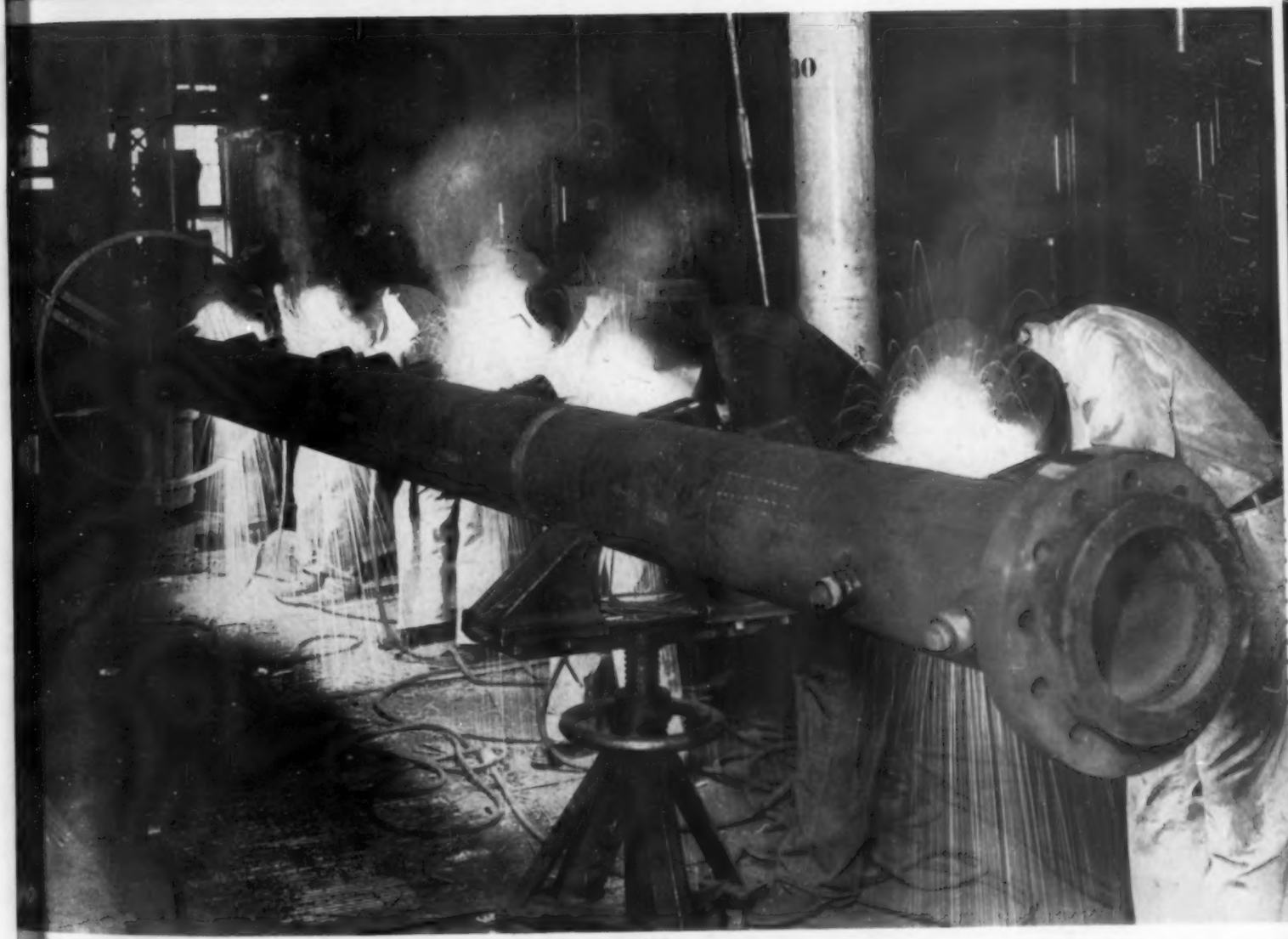
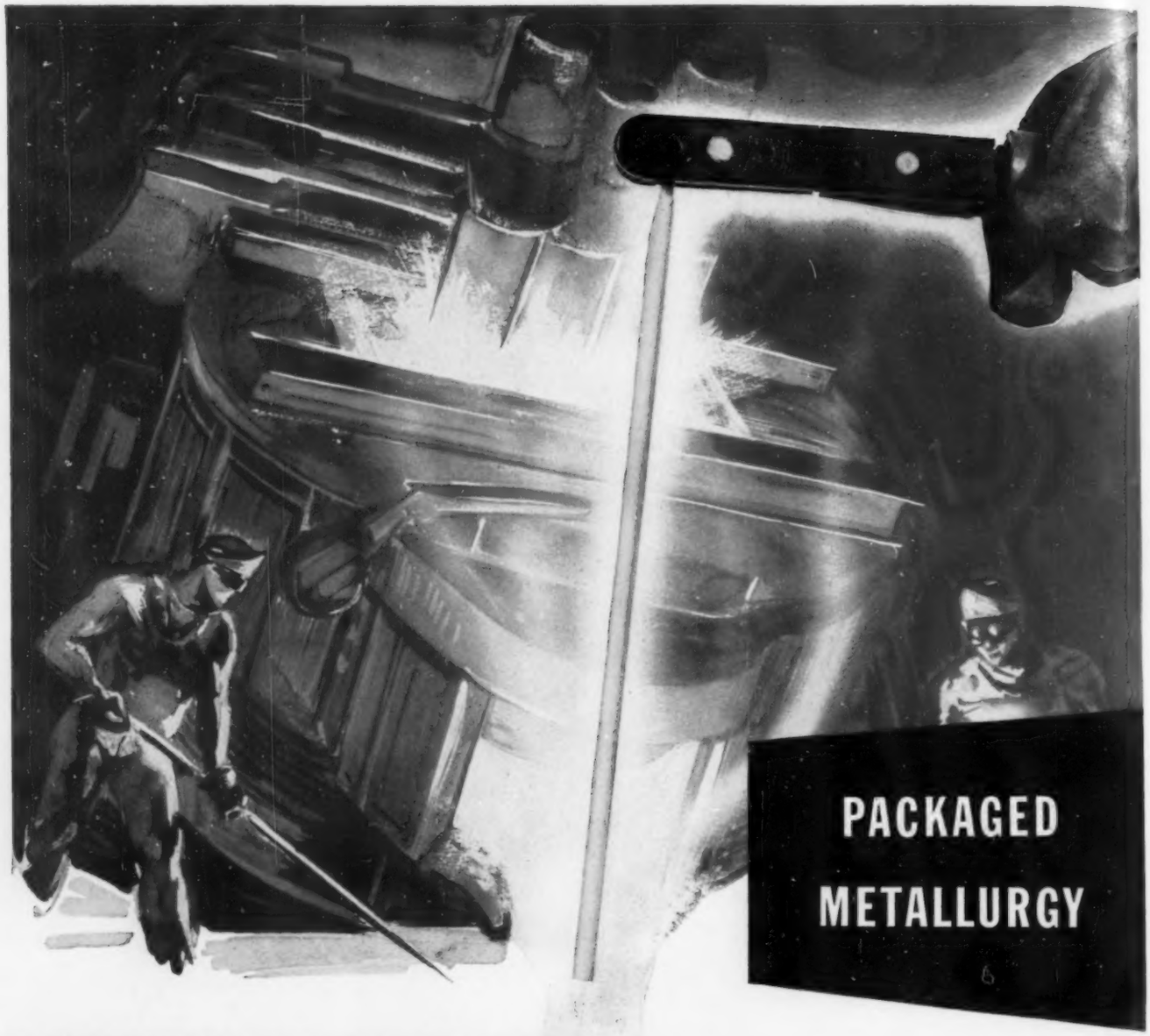
AUGUST 1946

WELDING Journal



The Journal of the American Welding Society



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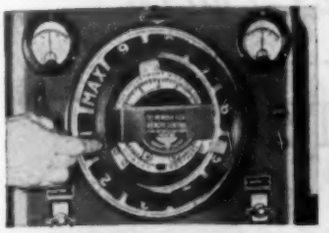

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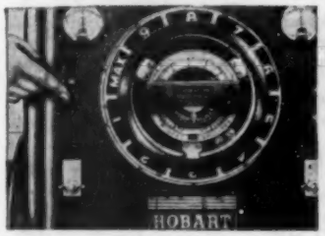

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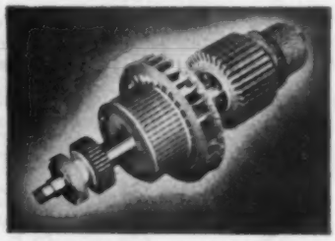

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Published for the Advancement of the Science and Art of Welding

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AUGUST, 1946

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Design and Fabrication of Welded Steel Reduction Gear Drives

By George L. Snyder*

DURING the war, naval victories glamourized the firing power of our big guns. Nonetheless important is the driving power or propulsion units involving gears and turbines, without which our Navy, our cargo ships and our transports would have been ineffective. As we have improved guns and armor plate, so we have developed motive power in ships. One of the developments in our Navy and Merchant Marine shipbuilding program was the welding of structural parts.

About 15 years ago when treaty limitation was one of the design criteria for our Navy ships, Lukenweld, Inc., division of Lukens Steel Co., Coatesville, Pa., began to collaborate with the DeLaval Steam Turbine Co. of Trenton, N. J., on the development of propulsion machinery of welded design. At that time reduction of weight and space requirements for ship propulsion machinery without loss of power output was an important factor in the design of naval vessels. It is hardly possible to discuss the subject of welded design without contrasting its aspects with phases of the foundry industry because structural parts of machinery traditionally have been castings. However, no implication is intended here that a struggle between the foundry and weldery should exist.

Cast gears, gear housings and turbine cases have been used for many years despite their size and complexity, which required that they be made in small units and assembled by riveting or bolting. These methods proved cumbersome and costly to achieve the end results. Today through the use of welded steel plate, the number of main units of a gear reduction drive is comparably fewer. Materials are selected to give a combination of strength, hardness, weldability and machinability.

The gear shown in Fig. 1 is a casting with a forged band shrunk on to the body and then hobbed. This gear weighs approximately 40,000 lb. By using welded construction we were able to design a gear to replace the one shown. By doing so, a saving of 10 tons in weight was effected for the welded gear weighs approximately 20,000 lb. During the designing of the welded gear several small steel models were made of both a spoked gear and a conical web gear. They were supported at the hub and a load was applied at increments around the rim.

Figure 2 shows the type of gears employed together with deflections which are characteristic of the two types. The curves were taken from two loads on the models of 220 lb. and 720 lb. and the resulting distortions of the rim of the spoked and conical types have been plotted as ordinates. The cone construction has uniform deflection from point to point around the periphery while the spoked construction has a variation of deflection of some 100% between the radial webs. Needless to add perhaps, the cone construction was adopted.

When the webs are formed as cones, several other advantages accrue. In welding the first web to the rim and hub, the welding operation tends to induce radial stresses. In such a design due to the conical shape of the web it can be readily seen that such tendency is dissipated in an axial movement of the hub. After the second cone is assembled the structure, of course, is thoroughly tied in together and its resistance to axial loads such as might occur in a helical gear is great.

Figure 3 shows the elastic deflection characteristic under an axial load and affords a comparison between the spoked and cone construction for an equivalent amount of material. The cone construction has roughly 78% of the axial deflection of the spider construction. The weight reduction in these parts is quite obvious in that plate gages can be reduced and no radial stiffeners are required; also by not having to assemble and weld these stiffeners the man hours to produce this type of gear are reduced.

As we know, a fundamental point in the development

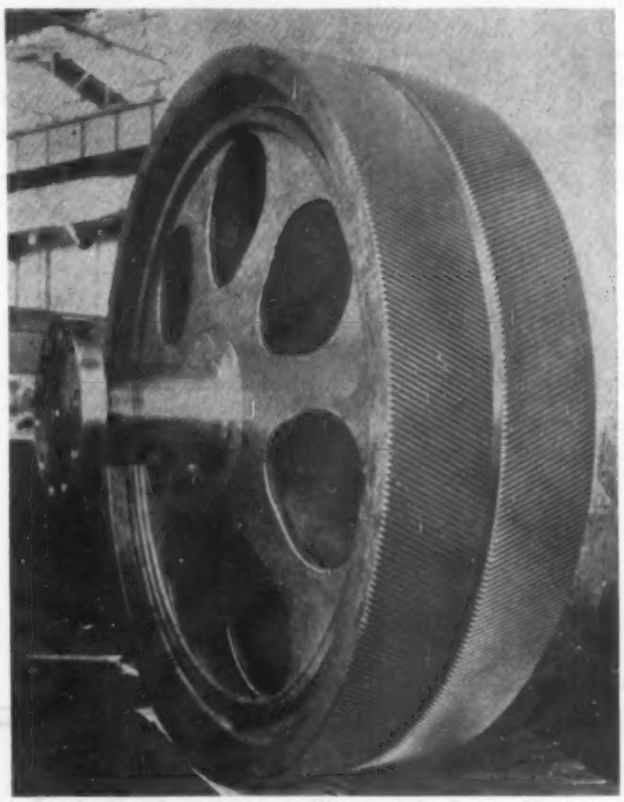

Fig. 1—Cast Gear with Forged Band Shrunk on to the Body and Then Hobbed

* Assistant Manager, Development Engineering Division, Lukens Steel Co., Coatesville, Pa.

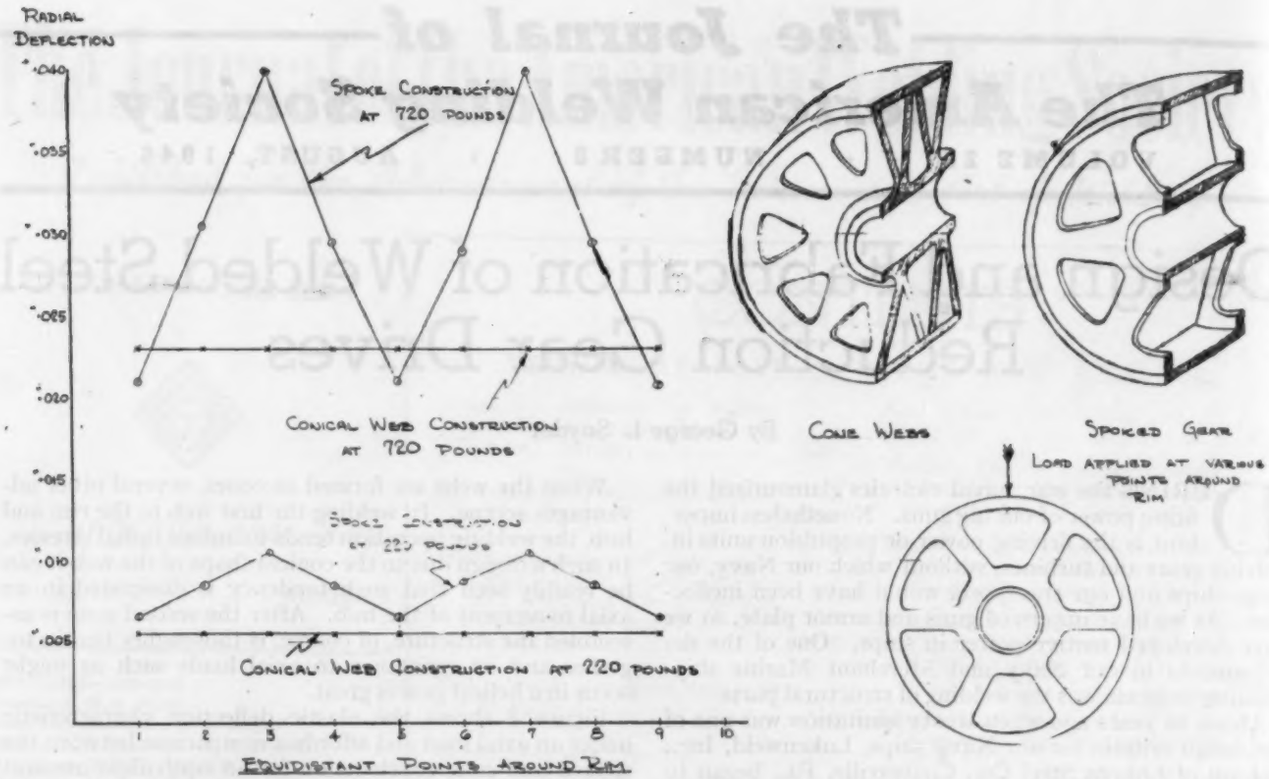

Fig. 2—Types of Gears Together with Deflections Which Are Characteristic of Them

of naval craft is minimum weight so that the maximum amount of fire power can be obtained with the minimum displacement of the ship. In our merchant vessels, the less the ship's parts weigh, the greater amount it can transport and the greater is its pay load. Based on the results of these deflections, hundreds of gears have been produced according to the conical design.

Figure 4 shows a welded gear blank for one of our naval transports using this type of construction. It is made of a forged rim, four webs and a hub. The gear blank is 155 in. in diameter with a face of 41 in. and weighs approximately 25,000 lb. In fabricating this weldment because of size limitations and availability of the forgings, the rim had to be made in two parts with a circumferential weld. The forgings have an analysis of 35 to 40 carbon and 90 manganese and Brinell hardness of 160 to 190 after stress relief. The forgings for the rim are tacked together and placed on a special welding positioner such as shown in Fig. 5 which rotates the assembly during welding so that all welding can be performed in the downhand position, after which the rim is bored on the inside diameter for close tolerances. The hub is made either from a forging or a casting turned on the outside diameter.

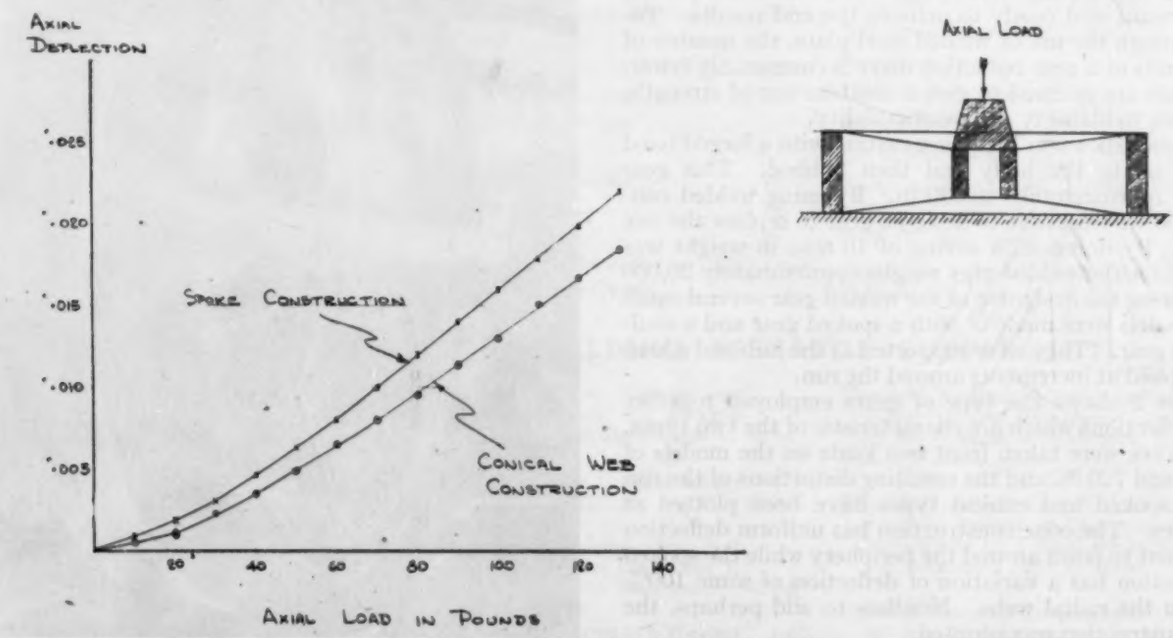

Fig. 3—Elastic Deflection Characteristic Under an Axial Load, Affording Comparison Between Spoked and Cone Construction for an Equivalent Amount of Material

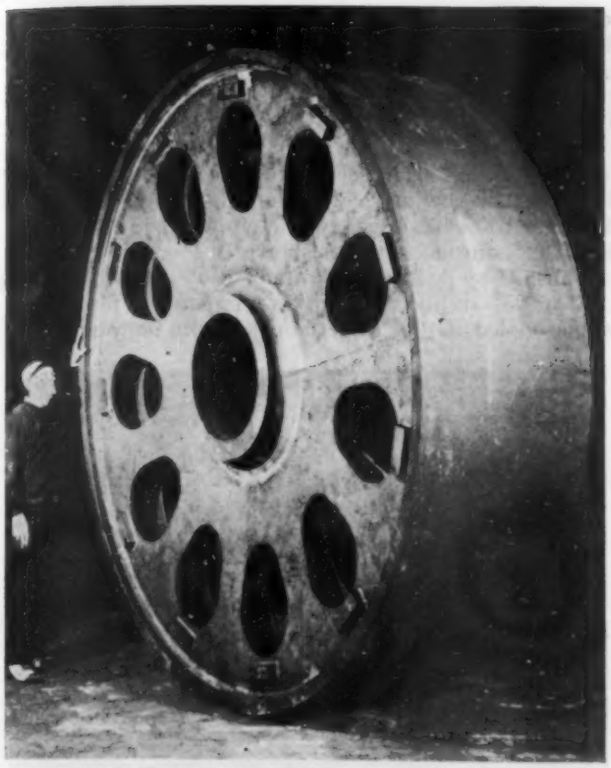

Fig. 4—Welded Gear Blank, 155 In. Diameter, 55 In. O.D. with a Face of 21 In.

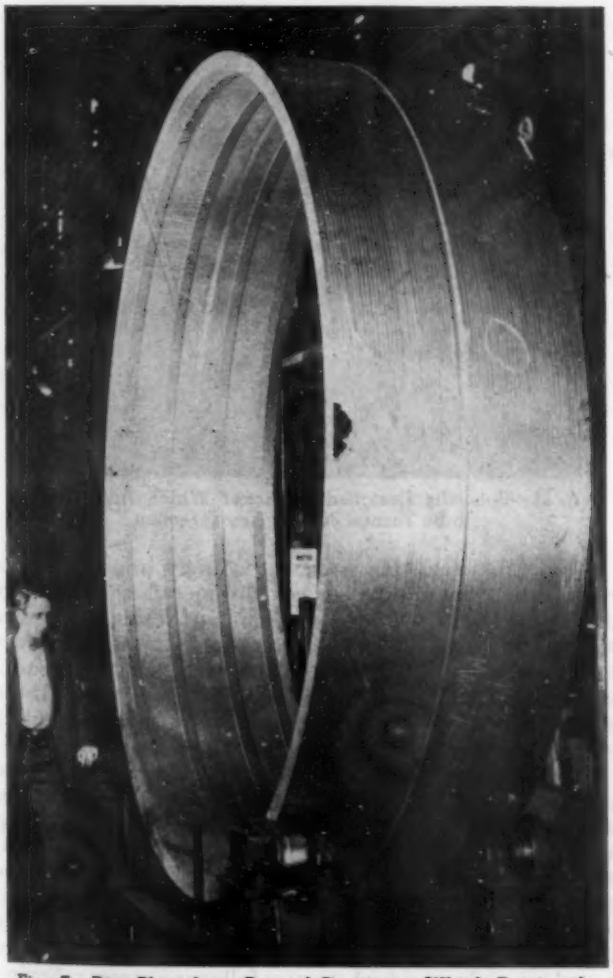

Fig. 5—Rim Placed on Special Positioner Which Rotates the Assembly During Welding Operations

The webs shown in Fig. 6 are first flame-cut on the inside and outside diameters, along with the holes from a single steel plate $^{15}/_{16}$ in. thick. The holes are used for accessibility in welding as well as to lighten the weight of the structure. An unequal number of arms are used to that no two arms are directly opposite. The openings are then ground to remove any torch marks or undercuts that may cause failure in pressing or in service.

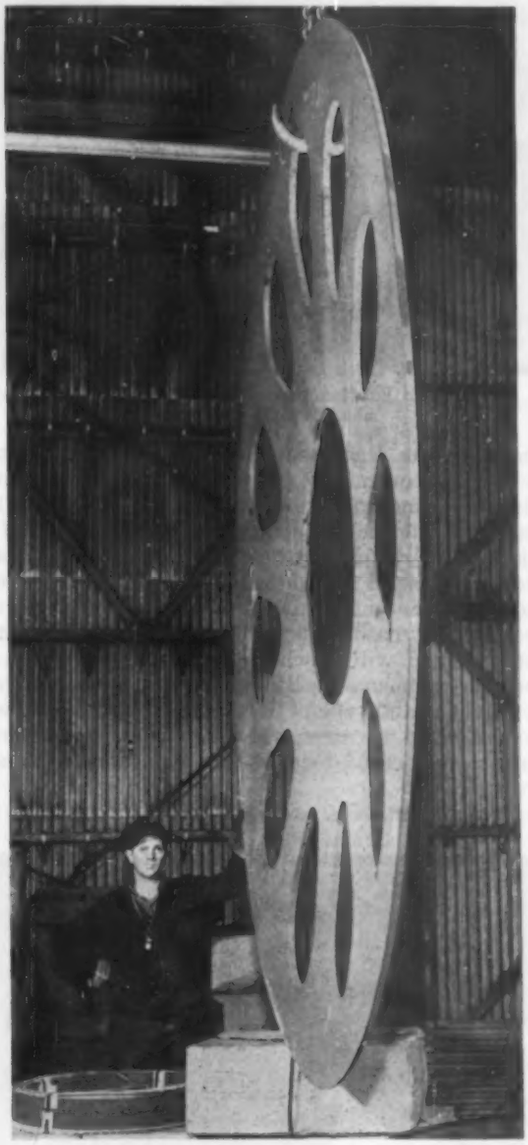

Fig. 6—Web Which Is Flame-Cut from a Single Steel Plate

Fig. 7—Assembling Gear by Heating Rim to Temperature of Approximately 250° F.

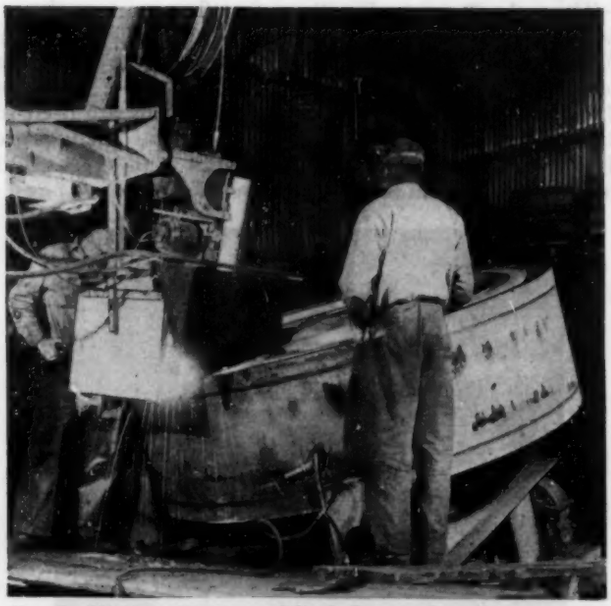

Fig. 8—Welding Positioner Which Rotates Gear Under Automatic Welding Machine

The webs are then shaped on a 1500-ton hydraulic press to a 5° conical slope. After pressing, the outside and inside diameters are machined. The welding kerfs are machined at the same time. The assembling of this gear is started by heating the rim to a temperature of approximately 250° F. as shown in Fig. 7 and the hub is placed in the center and the webs assembled. The rim is heated for two reasons: first, because of the difficulty of welding a steel with a carbon content above 30 and, second, the webs are machined with an interference fit. With this heat and type of fit, the shrinkage due to welding is minimized, because as the rotor is being welded the rim is cooling thereby tending to equalize the weld metal contraction.

The two inner webs are assembled and welded first, followed by the two outer webs. This assembly procedure is used to facilitate welding. The rotor is placed on a specially designed welding positioner which rotates the gear under an automatic welding machine at a 15° angle. This is shown in Fig. 8.

During each revolution the slag from the coated rod is removed so that each welding bead is laid on clean metal. The welds on the inside of these webs are made by hand. After the rotor has been completely welded it is stress relieved in a furnace such as shown in Fig. 9. This is accomplished by heating at a rate of 100° F. per hour up to 1200 ± 25° and holding at this temperature for 6 hr. It is then cooled at 100° F. per hour to room temperature.

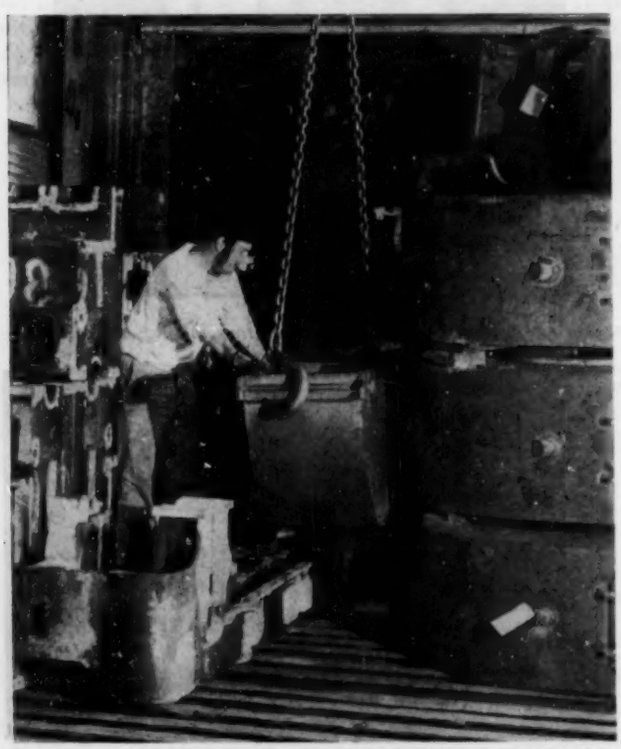

Fig. 9—Furnace Such as This Is Used at Lukenweld, Inc., for Stress Relieving Rotors

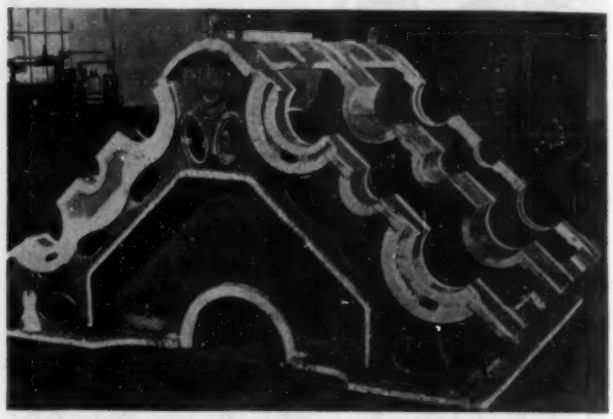

Fig. 10—Upper Gear Case with Cutouts to Give Accessibility for Internal Welding

Fig. 11—Specially Designed Positioner Which Allows Work to Be Turned 360° in Any Direction

This stress relieving is an exceedingly important procedure not only to help correct any metallurgical change during welding but also to remove residual stresses which are locked up in the structure. Cases have been known where these stresses have reached 30,000 psi., which is nearly the yield point of low-carbon steel. If the structure is loaded in the same direction as such welding stresses, there is no apparent strength.

Another important necessity for stress relieving is to insure that during machining on planers or boring mills, etc., there will be no warping or twisting due to locked-up stresses. Instances have been known where unannealed welded structures, over a period of only two years, have crept badly out of shape in service. The proportional limit of steel is roughly 2000 lb. to the square inch at a temperature of 1200° F. Thus, if the time is stress relieved properly, residual stresses following stress relieving should not exceed this limit.

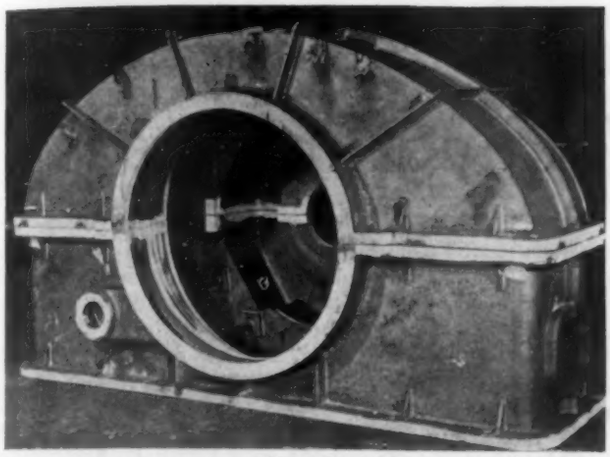

Fig. 12—Top and Bottom Half, Welded Steel Turbine Housings Fabricated by Lukenweld, Inc.

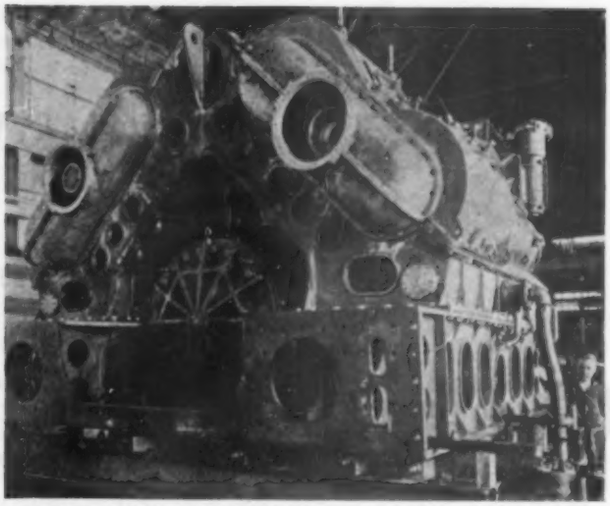

Fig. 13—Completely Welded Gear Case After All Machining and Assembling. The Unit Shown Is Ready for Installation

Brinell readings are taken again after stress relieving in order to determine that hardness has not been reduced in the furnace. Hardness may be reduced by heating above the drawn temperature of the forging.

Figure 9 shows the rotor after it has been grit blasted and the welding spatter has been removed. The gear blank is then ready to have helical herringbone teeth cut in the outer rim. After this operation the gears are then lapped in oil and ground glass to a tolerance of ±0.0005 for a considerable number of hours in an air-conditioned room to "break them in." This tolerance must continue for the life of the gears. Gear cases in which gears of this construction are housed are fabricated also of welded steel.

The upper gear case is shown in Fig. 10. The transverse members were cut from steel plate with cutouts to give accessibility for internal welding as well as to reduce weight. The fore and aft plate that fit under the bearing supports and form the bottom of the arch are formed on a bending brake. Six relatively small steel castings are used for the bearing supports. These castings undoubtedly could be fabricated from steel plate but would be more costly. The castings are small enough in size and properly designed so that a steel casting is satisfactory.

After assembly, the case is placed on a specially designed positioner as shown in Fig. 11 so that it can be turned 360° in any direction thus permitting all welds to be made in the downhand position, a procedure which is more predictable, easier and considerably faster.

Figure 12 shows the bottom and top half of a welded steel turbine housing. These pieces were redesigned from steel castings that weighed 16,000 lb. into welded construction that weighed 13,000 lb. The top half was made in one piece instead of two, thereby eliminating extra machining and bolting. We are told that machining time on these items was reduced by approximately 20 to 25% because of less stock to be removed. This reduction in time does not include any repair time that was needed because of porosity or blowholes that might appear in a casting of this size. It has been stated by one of the major builders of this type of propulsion equipment that a weight reduction of approximately 30% has resulted from the use of welding with proper design.

Figure 13 shows a completely welded gear case after all machining and assembling. The unit as shown is ready to be installed in one of our Navy fighting ships, transports or one of our Merchant Marine vessels.

The art of welding two pieces of steel into one is gradually becoming a science. The principles are well known. The greatest unexplored field today is the design possibilities that are inherent in this fabrication method. The possibilities are unlimited.

The Selection of Welding Processes*

By W. J. Campbell†

ONE of the most important aims of welding organizations should be to improve welding and thereby advance its use in industry. I believe that close control by planning is one way to bring about this improvement.

The increase production requirements of the war were a motivating element in the large-scale education of men and women in the field of welding. However, there is still a long way to go. We need engineers, supervisors and planning men who are thoroughly acquainted with all forms of welding.

Ordinarily the designing engineer lays out a job indicating dimensions, finishes and heat treatment, where required. He then leaves it up to others such as the Planning Department and Manufacturing Department to determine the best and most economical means of arriving at the desired results. It doesn't work that way with welding. Few planners are familiar enough with welding to designate reliably the process.

In most cases, the designer indicates the type and location of welds and the preferred method of applying these welds. This is as it should be, since the designing engineer is responsible for the finished product. Here we run into difficulties. Too few of our designers are thoroughly familiar with welding, so that the factory often finds it necessary to request changes in order to do a satisfactory job. This method may give us the desired results but a great deal of time is lost, and perhaps some work may be scrapped. The ideal situation would be to have an experienced welding engineer to assist the designing engineer. This welding engineer would be familiar with the facilities available and how they could be best applied. He would recommend process, joint design and the assembly sequence. He would see that welding notations on the drawings are correct, and understandable to the shop, and issue with the drawing, or as a separate reference, a procedure. This procedure will be a planned program for welding either based on standard data, already available, or obtained by experimentation. When the job reaches the shop there would be no question of the successful fabrication. Although this is an ideal situation, it is not beyond our reach. We should work toward this end. If a manufacturer has no previous data or experience, he can get an excellent start by using the standards set up by the AMERICAN WELDING SOCIETY as a guide. These standards have been set up by experienced men from many parts of the country whose efforts have been toward the improvement of welding in all fields.

In the General Electric Co. we are also shorthanded in skilled welding technicians, so we have adopted a system of operation which you may find of interest.

Most of our welding engineers and technicians are grouped together in each plant under a laboratory setup. Equipment is available for development of process data and procedures, but the primary functions of this group are as follows:

1. This group acts as consultants for the Engineering and Manufacturing Departments.
2. As trouble shooters, these men supplement the routine shop inspection.
3. Train and qualify operators.

These are day-to-day functions, but along with these functions a long-range education and standardization program is underway.

General procedures are drafted from actual experience and, when necessary, from development.

A comprehensive standardization plan has been outlined and will be issued as manufacturing process specifications. These specifications and procedures are distributed to engineers, inspectors, supervisors and planners. Processes, joint design, drafting practice and electrode recommendations are easily referred to so that by frequent reference to this information the users soon become familiar with the routine welding questions. We hope that this will leave our laboratory group free to handle only special problems and to spend more time on continued improvement of processes and facilities.

Available Facilities.—Let us consider some of the factors which are important in planning our welding. For instance, what facilities do we have? By available facilities we refer to equipment, processes and, of course, trained personnel. Perhaps our oldest methods of welding are forge and Thermit welding. These processes are used in special applications and are not ordinarily recommended as manufacturing processes.

Gas welding is probably our next oldest method of welding. Because of the wide ranges of heat input and the ease of handling, this is perhaps the most versatile of all welding processes. The equipment for gas welding is both economical and portable, and therefore a logical choice for small welding shops. In spite of these favorable features, gas welding has been replaced as a manufacturing tool, in many cases, for several reasons. Probably the most important of these reasons is welding speed. (*a*) On thin gages, with the proper joint design, a good operator can get high welding speeds using this process, but when the stock thickness is above $^1/_{16}$ in. an arc-welding process will give much greater speed. (*b*) Distortion is greatly affected by the rate of heat input. Using a gas flame, the lower rate of travel (also heat input) allows the heat to be conducted away from the joint by the base material, thereby causing expansion over a wider area. This causes higher thermal stresses which increase the buckling and warping. It is true that in a gas weld the heat-affected zone is wider and therefore not so apt to give a notch effect. However, where the sharpness of the heat-affected zone is important, uniform preheating can be used together with arc welding to give even better joint uniformity. Until recently arc welding could not begin to compete with gas welding in the field of aluminum, magnesium and copper alloys. Excellent welds can be obtained on these materials with gas at fairly high welding

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† Electric Welding Division, General Electric Co., Schenectady, N. Y.

rates, but in practically every case initial preheat and flux are required.

The most widely used welding process in manufacturing today is the metal arc process. For several years this process has been widely employed in manufacturing, and the recent developments in electrodes for welding nonferrous alloys have further increased the use of this process. High rates of manual welding are obtained by the metal arc process and much greater rates are obtained by various automatic metal arc processes. This process can be used to advantage for making fillet welds and groove welds in material thickness from $^1/_{16}$ in. up.

The atomic-hydrogen arc process is proving to be almost as versatile as the oxy-gas (Here the arc is established between two tungsten electrodes and enveloped in hydrogen gas. The hydrogen gas acts as a heat transfer medium as well as a shielding medium.) Because the arc is established in this way, the heat can be applied in the same manner as the gas flame. The temperature of this arc is much higher than the oxyacetylene flame, thereby giving an increase in welding speed over gas welding. During the past several years, atomic-hydrogen arc welding has been used extensively for the fabrication of light gage stainless alloys and aluminum.

Because the hydrogen forms a reducing atomsphere around the weld, most materials can be welded without the use of fluxes. Aluminum, however, requires a flux.

A newcomer in the field of arc welding is the Inert-Arc process. I say newcomer, because it is only in the last three years that the process has been used in manufacturing. Actually the first work in this field was done by two G-E Engineers, Hobart and Devers, disclosed in patents issued in 1930. Because of the scarcity of helium and argon at the time, no practical use was made of the process. In this process the arc is struck between the work and a tungsten or carbon electrode in an atmosphere of helium or argon gas. Now that these gases are available in quantity and at a fairly low rate, new applications are being discovered daily. Advantages of this process are high welding speeds, variety of materials weldable, elimination of flux in most cases, and the wide range of thickness that can be welded. Work has been done on stock as thin as 0.010 in. and as thick as 1.0 in., and in many cases without the necessity of beveling for butt joints up to $^1/_2$ in. So far in our work we have had good success in welding almost any metal which is weldable by any other process. This includes aluminum, magnesium, copper, stainless steel, Monel and mild steel. The process is readily adaptable to machine welding as well as manual welding. This process may not always be the most economical or most adaptable. Here again proper consideration must be given to all phases before deciding on the process.

In the pressure welding field the resistance methods have proved to be valuable production tools. The most commonly used methods are seam, spot and projection welding. We naturally look to resistance welding where light gage parts that can be easily handled between the electrodes or rollers are concerned. A minimum of distortion is obtained and rates of welding are high. This method is especially adaptable to high production jobs. Even though we usually think of resistance welding in connection with light gage material, considerable spot and seam welding have been done on heavy sections. Also in the pressure group are butt and flash welding. Butt welding may be done by heating the metal electrically and applying pressure to forge the pieces together. Butt welding is used where a closely controlled joint contour is necessary. The flash welding process derives its heat by the establishment of an arc between the faces to be joined. The upset pressure is then applied slightly before or in some cases slightly after the current is interrupted. Heavy sections can be welded in many shapes and sizes by either process. Light material is also welded in sheet form or tubing. High production is necessary in order to defray the relatively high cost of this equipment.

There are also many specialized processes such as stud welding and dot welding, in which the applications are usually obvious.

Joint Design

Regardless of the process used, we must give careful consideration to the joint design. Two factors of prime importance in joint design are: (*a*) material, thickness and composition; and (*b*) the joint preparation.

Material

(*a*) In the first place the material composition must be considered with regard to its weldability. While most metals can be welded, the operation may not always be successful. Because of certain properties of the material, the welding may have a harmful effect on the base metal. These effects can be reduced by proper welding procedure, but a very detailed procedure must be worked out to get best results.

Some materials, such as low-carbon steels, are considered easily welded. We expect little harmful effects in the base metal from welding.

Joint Preparation

(*b*) Regardless of the metal being welded, the preparation of the joint for welding should be carefully planned and prepared. In selecting the joint, several factors may be considered. Design strength is naturally the most important, with plate thickness next in importance. The appearance of the finished product is also a factor in joint selection. Some standard joints encountered in fabrication will now be discussed with reference to processes which are applicable. It might be said that, in general, where proper electrodes are available, the metal arc process is used for heavier stock, that is $^1/_{16}$ in. and over.

1. Type of Joints.—Butt joints may be used in any thickness of material but the joint preparation varies with thickness. That is, in thicknesses up to and including $^1/_8$ in. the weld may be made with a square-butt preparation, but over $^1/_8$ in. some type of groove must be provided to allow complete penetration. For machine welding, of course, these general statements would not apply. If the plate thickness is $^1/_{16}$ in. or less we may use gas, atomic-hydrogen arc, or the Inert-Arc process. For plate thicknesses above $^1/_{16}$ in. these processes may also be used along with metal arc welding. Generally greater speeds can be obtained by use of the metal arc either manually or in one of the several machine welding processes. As previously mentioned, the flash and butt welding processes can often be used where high production warrants the expense of the equipment.

A T-joint is one requiring a fillet weld. Here, again, we find the oxy-gas flame on heavier materials is too slow for efficient manufacturing. The atomic-hydrogen arc is not easily controlled for fillet welds. The metal arc can be manipulated to give the desired weld contour at satisfactory welding rates. Resistance welding may be applied if the leg of the T is flanged and so located as to be accessible for handling between electrode or roller wheels.

A lap joint may be welded by any of these methods except flash or butt welding. This type of joint may be used to eliminate the addition of filler. If this is done, the metal arc process is eliminated as possibility.

The so-called corner joint is often used to replace a T-joint on thin material. In this way the oxy-gas flame atomic-hydrogen arc or Inert-Arc may be used to give high welding speeds and smooth appearance. On heavier

stock, 1/8 in. and over, the metal arc may also be used. A corner weld may often be used to reduce distortion.

The edge weld is used in a few cases when the joint is not apt to be subject to flexure. This type of joint is especially useful if the material is extremely thin so that a butt or corner weld would be difficult to apply. Usually no filler metal is required for this joint.

In many cases, a butt type joint is desired on thin material and for reasons of speed or composition it would be unhandy to add filler. Then a flange type joint is used. This requires that one or both of the abutting edges shall be turned up. This flange is melted down so that there is little or no evidence of having been flanged and a slight reinforcement is provided on both face and root. Flanges should be turned carefully so that they fit squarely and so that no excess of metal is left to be melted down. A good starting place for flange width is usually twice the thickness of the stock.

2. *Method.*—The method of preparing these joints may have a great deal to do with the success of the welding operation. For most manual welding operations a first-class flame cutting job or shearing should be satisfactory since the operator can compensate for some variations. Poor fit-up, in any case, will cause greater distortion. Most machine welding operations require very close fit-ups and uniform preparation. In such cases joints should be machined.

3. *Accessibility.*—Often designs for welded structures are prepared with no consideration given to the accessibility of the joints. A poor quality weld may be made if the operator cannot approach the job with ease. In some cases it may even be impossible to do the job at all. For the most economical use of welding, work should be positioned so that all welds can be made in the flat or horizontal position, so that the operator can assume a comfortable position while working.

4. *Cleaning.*—No matter what welding process you select, cleaning is an important item in joint preparation. It is true that for some processes it is more important than others, and more important for some materials than others. Generally speaking, we find that oil, dirt, grease and paint should always be removed. This can be accomplished by brushing, wiping with a cleaner, or by dipping in a hot cleaner. Every good operator is aware of these requirements and insists on thorough cleaning before he welds. Some materials, however, may collect a scale or oxide which is not always evident to the naked eye. Mill scale on steel should be removed by grit blasting, wire brushing or some other satisfactory method. This scale, if taken into the weld deposit, is apt to cause excessive porosity and slag inclusions. Excellent welds may be made on stainless alloys with only the mill finish if cold rolled. The foreign particles must, of course, be removed, but pickling is not often necessary or even helpful. Aluminum and magnesium alloys, on the other hand, will rapidly accumulate oxides on the surfaces even at room temperature. These alloys should be cleaned by acid dips or by special cleaners to remove the oxide. They should be cleaned not more than five hours before welding. If it is necessary to let parts stand overnight, they should be recleaned. This applies to fusion welding as well as to resistance welding. Fluxes may be used to remove these oxides, but better results will be obtained by precleaning. This does not mean that the flux can be always eliminated if cleaned before welding, because the instant the temperature of the aluminum and magnesium alloys, for instance, is raised above the room temperature, oxidation takes place more rapidly, so that flux is needed to prevent further oxidation unless the heated area is shielded from the air. If atomic-hydrogen arc or Inert-Arc is used, thorough cleaning is all that is required for successful welding of most materials. As far as we know at the present, only aluminum requires flux when welded by either of these processes, and even this has an exception. If a.-c. current and argon gas is used, then flux is not necessary for welding aluminum.

Procedure

Having made ourselves familiar with the facilities available and the standards set for welding, we must then consider each job on its own merits. Whether it is a factory job or a project in a small job shop, a procedure should be drawn up and followed. This procedure, in a job shop, may only be an organization of the operator's thoughts, but it would be a preplanned procedure of operation. Close control of welding quality can be maintained if procedures are properly prepared and followed.

A. This procedure should include the following items:

1. The process to be used, including heats, speeds and equipment.
2. The specification of base material and electrode or filler material. The filler material should be chosen with care, so that the deposit will compare favorably with the base material. The electrode size should also be stated.
3. Joint preparation
4. Preheat, if required.
5. Cleaning method.

Sequence

Distortion from welding cannot be eliminated. It can be minimized and compensated for if a proper welding sequence is planned. Our procedure should include such a sequence. One point to remember is that the distortion will be approximately proportional to the number of heat applications regardless of the process used. Some common methods of controlling distortion are proper joint design, fixturing, preheat, wander-sequence of welding, peening and finish machining. I mention the latter in connection with the control of distortion because often a great deal of expense and trouble can be saved if the machining is planned to include allowance for distortion from welding.

While the post-treatment may not be considered as part of the welding procedure, it does affect our planning when preparing the procedure. We should know whether a heat treatment will be given after welding, whether straightening is planned, and what system, if any, is to be used for cleaning. The method of inspection to be used is also important.

Conclusion

Perhaps you have gathered from my talk that I feel that planned welding is perhaps the most important factor in the advancement of welding. We in the welding game have a big future ahead of us in the new industrial era just dawning. We can't sit back and "collect" on our past experience. We must strive continually for better methods and improved uses of existing methods.

The Interpretation of Radiographs of Spot Welds in Alclad 24S-T and 75S-T Aluminum Alloys

By Robert C. McMaster* and Frederick C. Lindvall†

Introduction

THE vast increase in aircraft production during the war created an urgent need for a reliable nondestructive method of inspection of spot welds. Such a test was required particularly for spot welds in high-strength 24S-T and 75S-T aluminum alloy sheets used in primary aircraft structures. Until reliable methods of proving spot-weld strength were developed, however, the spot-welding process was generally limited to the production of secondary structures whose failure would not imperil the airplane and its personnel. Most aircraft manufacturers found it expedient to rivet joints in primary aircraft structures. The possible advantages in speed and economy of spot-welded joining, in comparison with riveting, were thus obtained in only a small part of the total production for which spot welding could have been used.

Research during the war period has led to the development of new instruments for the rapid measurement of spot-welding current and tip force during welding.‡ With these instruments it is feasible to make continuous, instantaneous checks of spot-welder performance during production welding. In addition, new radiographic techniques and methods of determining spot-weld strength and quality from radiographic images have been developed. These make possible rapid, reliable, nondestructive spot-weld inspection which can be carried out either directly after the weld is made or at any later point in the fabrication process.

Methods of interpreting weld strength and quality from radiographs have been developed rather completely for the case of two-layer equal thickness combinations of Alclad sheets of high-strength aluminum alloys, such as 24S-T and 75S-T. Both of these materials are ideal for radiographic inspection of spot welds. Each contains a

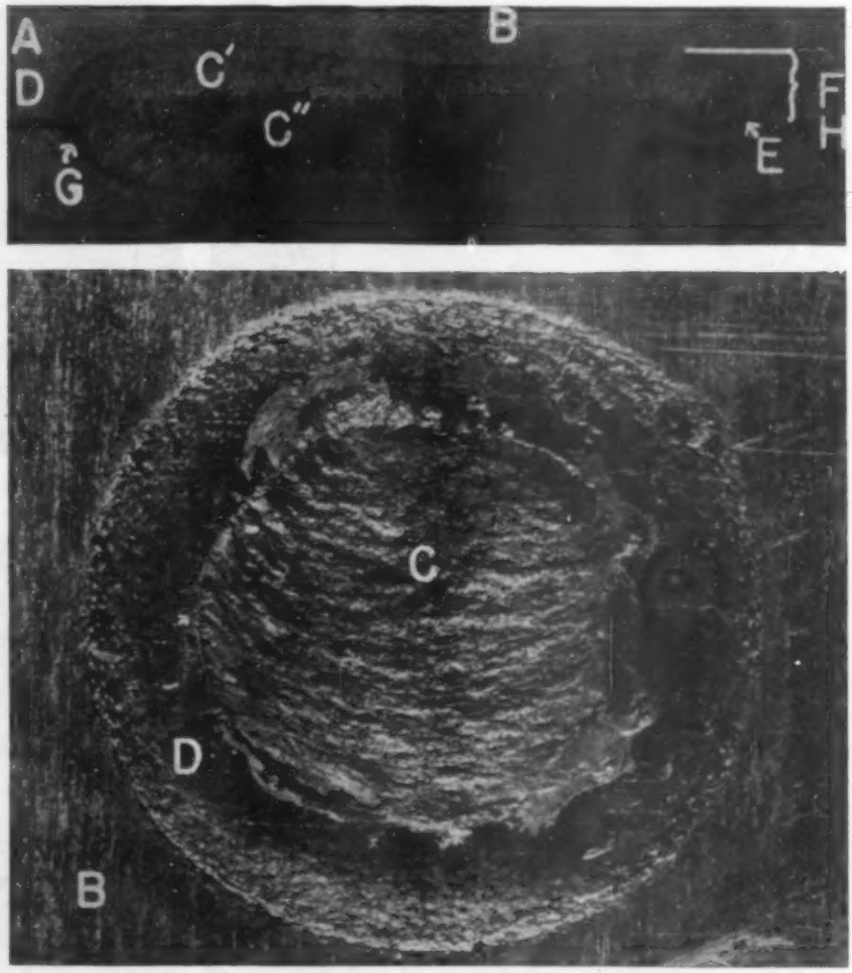

Fig. 1—Cross Section and Faying Plane of a Typical Spot Weld in 24S-T Alclad Aluminum Alloy, Showing Significant Regions of Weld. 15 ×

(*A*) parent material, (*B*) Alclad layer, (*C*) cast alloy nugget, including (*C'*) dendritic zone and (*C''*) equiaxed zone, (*D*) corona, (*E*) Alclad inclusion, (*F*) penetration, (*G*) heat-affected zone and (*H*) faying plane.

EDITORIAL NOTE

This paper is the first of a series which will cover research on spot-weld radiography conducted at California Institute of Technology during 1943 and 1944 for the National Defense Research Committee under the supervision of the War Metallurgy Committee, and related research on the fatigue properties of spot-welds at Battelle Memorial Institute, sponsored by the N.A.C.A. The interpretation of radiographs of spotwelds in high-strength Alclad aluminum alloys is discussed in this paper. Succeeding papers will discuss the radiography of spotwelds in other sheet materials, the classifications and recording of spot-weld radiographic indications, radiography of spotwelds in various sheet thickness combinations, radiographic technique and equipment, and the fatigue properties of spotwelds.

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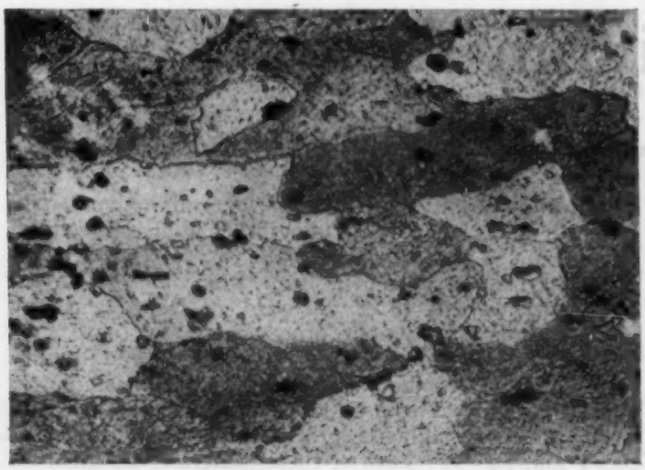
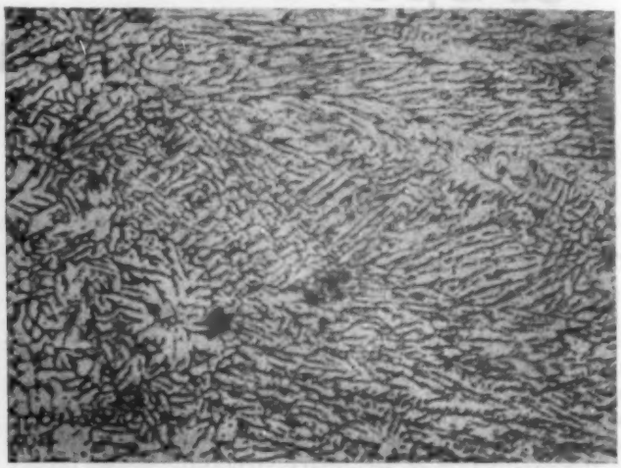
‡ See Bibliography at the end of this paper.

relatively large percentage of a radiographically dense alloying constituent which makes it possible to obtain clear, high-contrast radiographic images. These images show clearly the structure in the weld region. They reveal the shape and area of cast-alloy bonding at the faying plane, from which weld strength can be estimated reliably. They show positive indications of the following weld defects, which are directly related to weld strength, strength consistency and the quality of spot-welding process control:

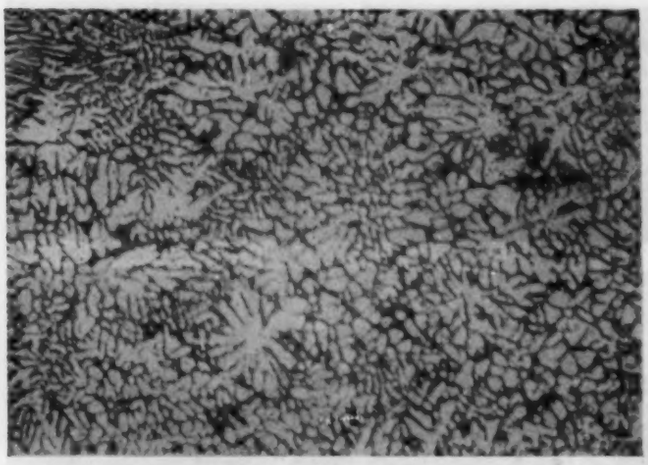
1. Absence of the weld nugget.
2. Undersize weld nugget.
3. Excessive Alclad inclusion into the weld nugget at the faying plane.
4. Doughnut- or crescent-shaped weld nugget.



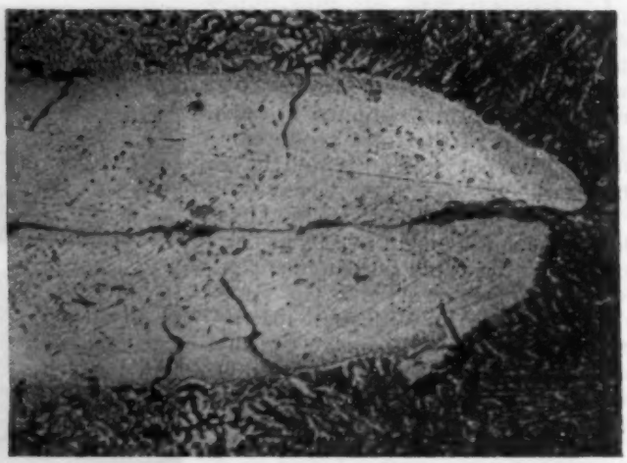
(*A*) Parent material, 24S-T aluminum alloy. 500 ×



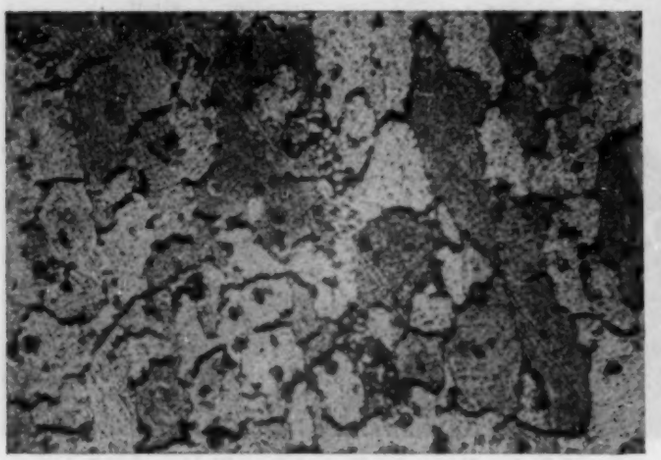
(*C*) Dendritic zone of weld nugget. 500 ×



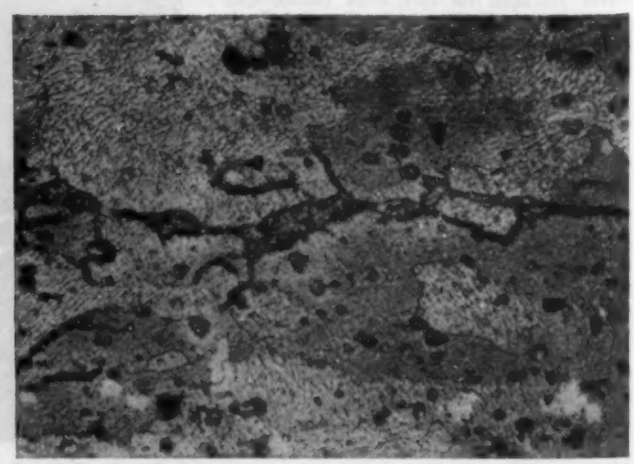
(*C'*) Equiaxed zone of weld nugget. 500 ×



(*E*) Alclad inclusion into weld nugget. 500 ×



(*G*) Heat-affected zone showing incipient melting at the grain boundaries. 500 ×



(*G'*) Heat-affected zone showing eutectic "stringer." 500 ×

Fig. 2—Structure in Typical Regions of a Spot Weld in 24S-T Alclad Aluminum Alloy Sheets

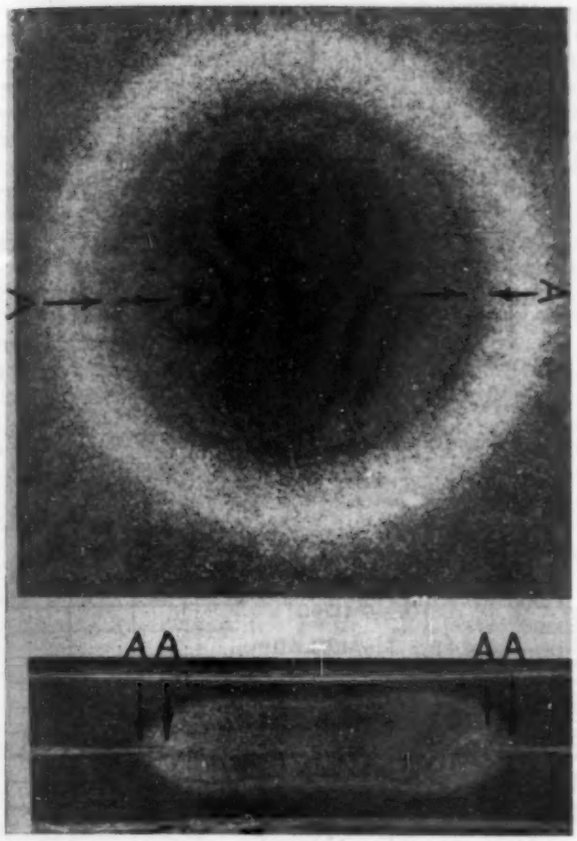


Fig. 3—Radiograph and Section of a Normal Spot Weld in 0.040-In. 24S-T Alclad Aluminum Alloy Sheets. 10 ×

The outer boundary of the prominent radiographic dark ring *A–A* shows the boundary between the nugget and the parent material. The inner boundary of the dark ring *A–A* shows the inner extremity of the Alclad inclusion into the nugget at the faying plane.

5. Cracking in the weld nugget.
6. Porosity in the weld nugget.
7. Inclusions in the nugget or at the faying plane.
8. Segregation of eutectic in the parent metal (often a sensitive indicator of welding heat).
9. Expulsion of cast alloy from the nugget at the interface ("spit").
10. Extrusion of the nugget at the faying plane (usually the cause of excessive sheet separation).
11. Oversize weld nugget (excessive diameter or penetration).
12. Misshapen weld nugget (often a sensitive indicator of poor or nonuniform sheet surface conditions, or of bad electrode tip contour).
13. Tip pickup (which results in alloying of copper from the electrode with the aluminum alloy of the welded sheet).

This paper presents simple rules for the interpretation and evaluation of these weld properties from spot-weld radiographs. These interpretations are presented for the use of spot-weld inspectors and process control engineers in industry. Figure 1 presents the weld nomenclature used in this paper. Figure 2 shows the structure of typical regions of a spot weld in 24S-T Alclad aluminum alloy sheets. It is assumed that the reader is familiar with spot-weld properties, and could use the following illustrations as a guide in radiographic spot-weld inspection and process control. The theory and technique of spot-weld radiography will be reserved for later papers.

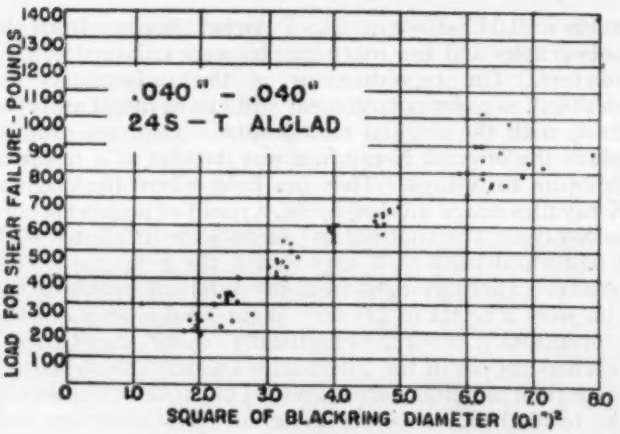
A few words concerning the radiographs are in order, however. All of the illustrations in this paper are of welds in 0.040–0.040-in. 24S-T Alclad sheets. Both the radiographs and the macrographs were enlarged ten diameters. The reproductions of the radiographs are identical, save for enlargement and loss of detail and contrast, with the original radiographs. They are darkest where the original X-ray film was darkest as a result of exposure to X-rays. They are light where the original X-ray film image was less dense, a result of underexposure to X-rays. The spot-welded sheets were irradiated with a uniform density of X-rays during the radiographic exposure. The variations in X-ray intensity reaching the film were a result of (*a*) very slight local changes in the concentration of radiographically dense constituents (such as copper in the 24S-T alloy) which absorb X-rays more than aluminum does, and (*b*) of slight differences in the total thickness of the material. The structure and shape of the weld nugget and the regions of segregation are revealed by the former effect. Weld cracking, porosity, nugget extrusion, expulsion and the corona ring are shown by the latter effect.

The radiographic technique used for spot-weld inspection is by necessity extremely sensitive. The aluminum alloy 24S-T, for example, contains only about 4.2% copper. Probably only a small portion of this is redistributed as a result of spot welding. To show these minor local changes in the percentage of copper by sharp radiographic images, particularly when the change occurs in a region which occupies only a small part of the total sheet thickness, requires extreme radiographic sensitivity. In these illustrative radiographs, a change of 0.1% (0.0008 in.) in the total thickness of the uniform sheet material would have been revealed. Hence, even fine cracks and porosity in the weld nugget are revealed by dense black images. Very minor thickness changes, such as the minute displacement and thickening of the cladding in the corona region, can be seen clearly. Since the X-ray film includes density differences nearly four times as great as those that can be reproduced on paper, much of the contrast originally present in the radiographs has been sacrificed in these reproductions, with further loss of detail through enlargement. The printed reproductions are therefore but a poor indication of the quality of the original X-ray images, yet they reveal most of the significant information required to interpret weld properties from these radiographs. It is believed that such images obtained with exposure times of the order of one or two seconds represent a substantial advance in radiographic technique.

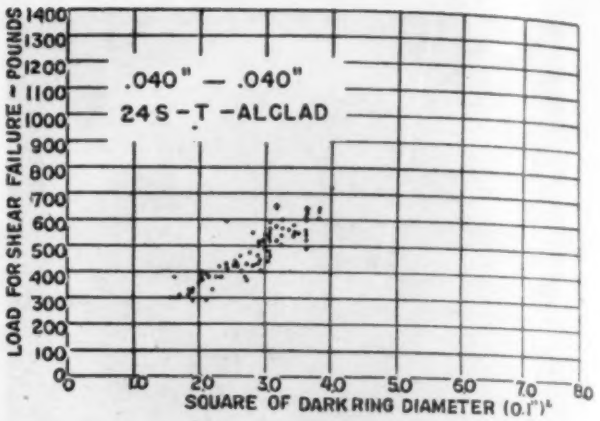
The Radiographic Dark Ring and Weld Nugget Geometry

The first feature to look for in a spot-weld radiograph is the prominent dark ring, *A–A*, shown in Fig. 3. The *outer* boundary of this dark ring shows the outer boundary of the spot-weld nugget in the parent sheet. The *inner* boundary of this dark ring shows the inner extremity of the Alclad inclusion into the weld nugget at the faying plane. These boundaries indicate, respectively, the weld-nugget size and the net area of nugget bonding at the faying plane. The static shear strength of the weld, in so far as it is due to the area of reliable bonding of *cast nugget alloy* at the faying plane, is indicated directly by the area enclosed within the dark ring.

The portion of the spot-weld static shear strength which results from *corona* bonding (which cannot be relied upon under all production conditions) is not measured by the area within the dark ring. Although the area of the corona region can also be determined from the radiograph, the strength of the corona bonding is not revealed.



CONSOLIDATED VULTEE AIRCRAFT CORP.
SAN DIEGO



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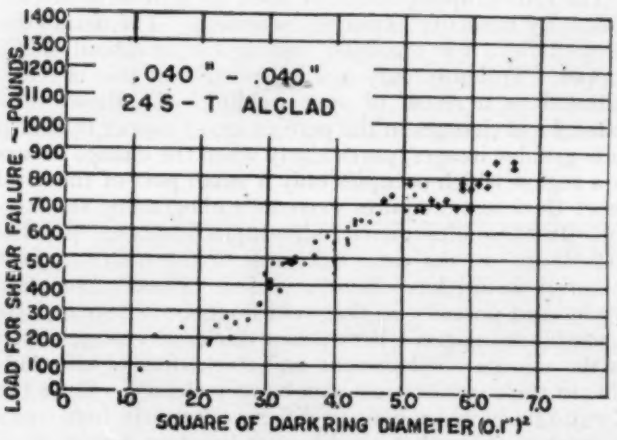
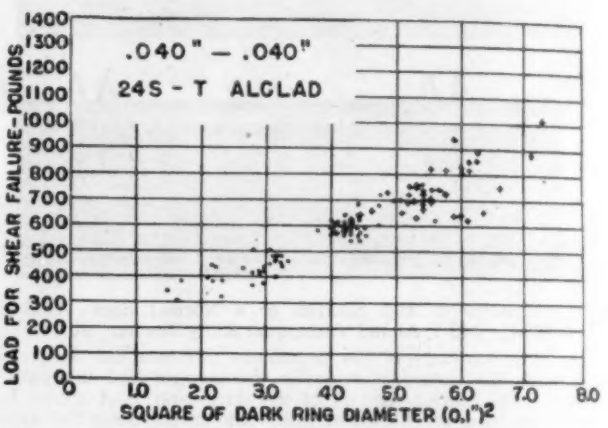
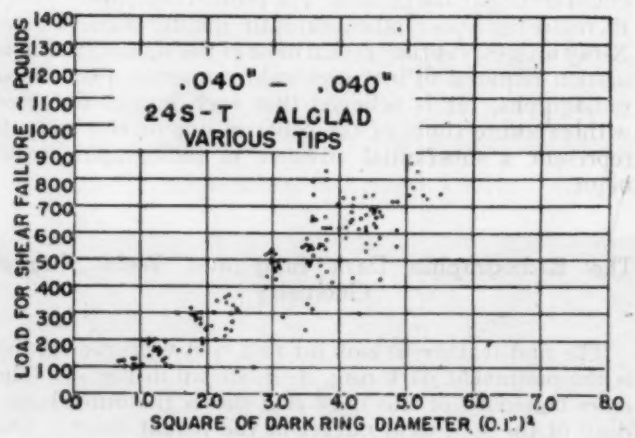


NORTHROP AIRCRAFT, INC., HAWTHORNE, CALIF.



LOCKHEED AIRCRAFT CORP.-A.



RYAN AERONAUTICAL COMPANY
SAN DIEGO

Fig. 4—Typical Correlations Between Load for Static Shear Failure (Ordinates) and Area Within Radiographic Dark Ring *A-A* (Abscissae) for Production Spot Welds from Several Aircraft Factories

Fig. 4 (Continued)—Typical Correlations Between Weld Strength and Radiographic Dark Ring

However, under well-controlled production welding conditions, corona bonding remains sufficiently consistent so that its strength contribution can also be estimated from radiographs.

In general, the corona bonding does not contribute to the ultimate tension strength of a spot weld. Since the corona bond may fail under service conditions before the weld nugget fails, it is conservative good practice to estimate weld strength from the reliably bonded cast nugget area at the faying plane. In this sense, radiographic inspection is a more reliable guide than static shear tests of weld coupons. In some cases, strength values from shear tests may be misleading, for it is possible to attain acceptable shear strength values in welds which have no nugget bonding whatever. Figure 4 shows the correlation between weld static shear strength and radiographic dark ring diameter, measured on production spot welds purposely made with widely varying shear strengths in several aircraft factories.

The dark ring occurs (*a*) because radiographically dense components of the aluminum alloy are expelled from the region of the boundary between the weld nugget and the parent metal, and (*b*) because the Alclad layer is less opaque to X-rays (being nearly pure aluminum) than the 24S-T or 75S-T core alloys. The geometry of the nugget boundary and of the Alclad inclusion at the faying plane determines the shape, diameter, prominence and width of the dark ring.

If the *dark ring is absent* from the radiograph, there is no weld nugget, as shown by the section and radiograph of Fig. 5.

If the *dark ring is of small diameter* (say less than three times the sheet thickness), the weld nugget cannot devel-

op the strength required of a nugget of normal size. Figure 6 shows a weld with a small diameter nugget.

If the *dark ring is broad* (in the case of smaller diameter nuggets) as shown in Fig. 7, the Alclad inclusion is excessive. This may be undesirable, since it weakens the weld. Only the area within the inner boundary of the Alclad inclusion is reliably bonded cast alloy or weld *nugget* material at the faying plane.

If the *dark ring is of normal diameter* (for acceptable weld nuggets in the gage and alloy being inspected), the weld strength will fall in the acceptable range. If the welding machine is operating properly within its capacity, this will usually be the range of greatest spot-weld strength consistency.

If the *dark ring is of large diameter*, as shown in Fig. 8, the weld static shear strength will be greater than normal. However, the strength consistency may be less than optimum, and small variations in welding machine performance may introduce serious defects such as severe nugget cracking and porosity, extrusion and expulsion. Usually, with such oversize welds, the heat-affected zone in the parent metal becomes excessive, and tip sticking may occur.

In very large welds with little or no Alclad inclusion, the *dark ring may be relatively broad*. The vertical projection of the curved boundary between the nugget and the parent material is correspondingly broad, as shown in Fig. 9. In some cases, the nugget has somewhat different diameter or shape in the upper and lower spot-welded sheets, resulting in a *splitting of the dark ring* into two concentric rings or parts of rings, as shown in Fig. 10.

In large welds, the dark ring may become difficult to distinguish or may even become invisible because the Alclad inclusion is completely absent and the nugget has been subject to extrusion at the faying plane. This condition is shown in Fig. 11. The outer boundary between the nugget and the parent metal has so little slope that the radiographically less-opaque region of the boundary is spread over a wide vertical projection. Its radiographic image thus becomes broad and has very little contrast, causing the dark ring to disappear. The nugget diameter can be found from other features of the radiograph in this case. However, the nugget extrusion, which usually causes excessive sheet separation and introduces the possibility of corrosion at the interface, is a rejectable defect in most cases.

Occasionally, *weld nuggets* have a *"doughnut" or "crescent" shape*. The radiograph reveals this condition clearly. Both the inner and outer extremities of the doughnut nugget are shown by radiographic dark rings, as in Fig. 12. Similarly the outline of a crescent (or incomplete doughnut) weld nugget is revealed by dark lines on the radiograph, as shown in Fig. 13. The net area of cast alloy (or nugget material) is determined by the area between the inner extremities of the dark rings enclosing the nugget region.

From the foregoing it is apparent that the radiographic dark ring *A–A* is highly important in the interpretation of weld strength from radiographs. It follows faithfully the outline of the bonded nugget area at the faying plane, revealing misshapen weld nuggets as in Fig. 14. Its

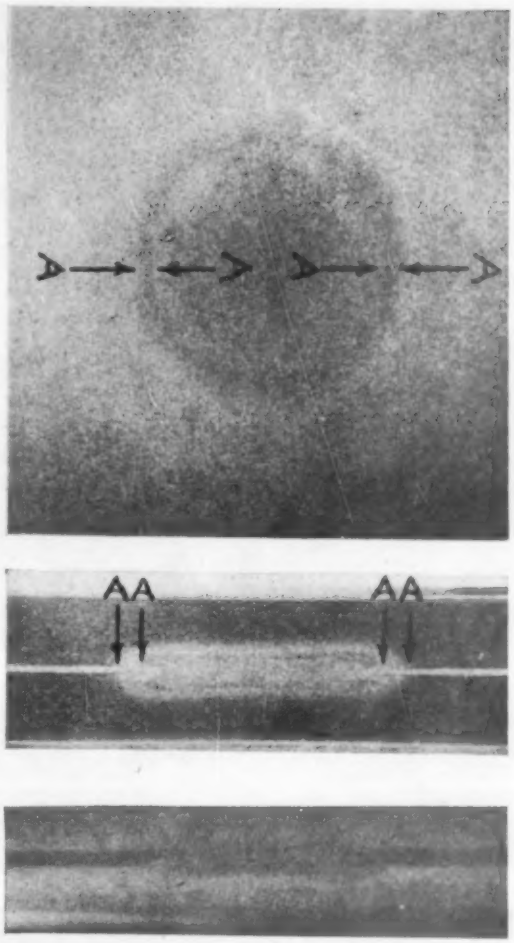


Fig. 6—Radiograph, Section and Section Radiograph of a Small Diameter Spot Weld

The small weld nugget diameter is shown by the small diameter of the radiographic dark ring *A–A*.

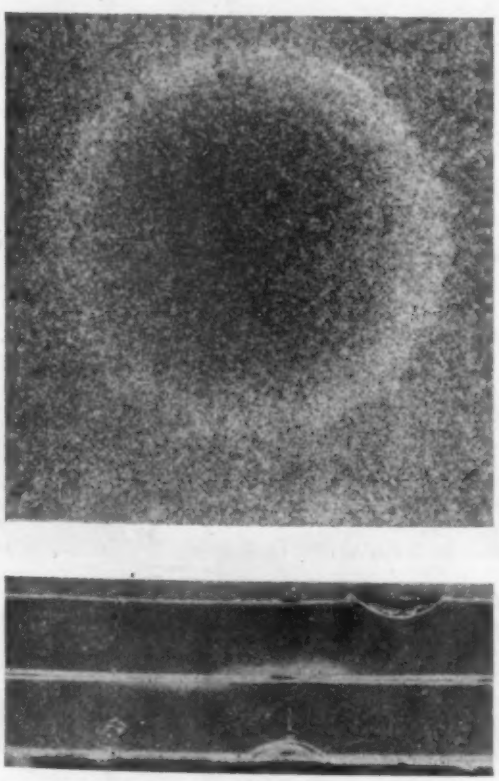


Fig. 5—Radiograph and Section of a Spot Weld in Which the Nugget Is Absent. 10 ×

The dark ring *A–A* is not present.

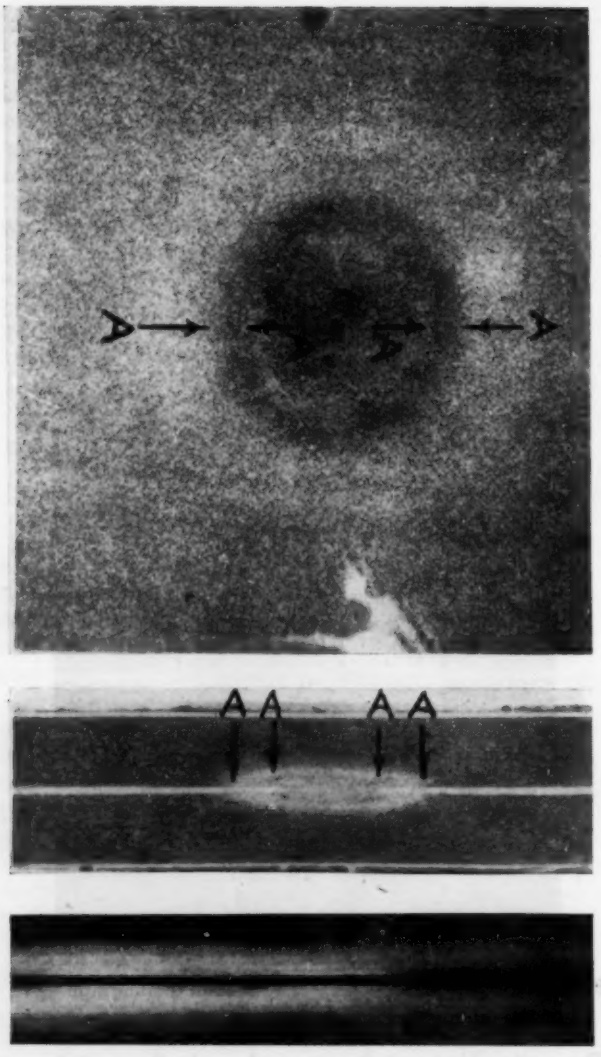


Fig. 7—Radiograph, Section and Section Radiograph of a Small Diameter Spot Weld with a Large Alclad Inclusion Into the Weld Nugget at the Faying Plane. 10 ×

The inner extremity of the Alclad inclusion is shown by the inner boundary of the radiographic dark ring *A–A*. The extent of the Alclad inclusion is revealed by the width of the dark ring, whose outer boundary corresponds to the boundary between the nugget and the parent material.

broadening or disappearance warns of excessive Alclad inclusion or absence of weld nugget in the case of small welds whose radiographic images have no other details. Its broadening or disappearance in the case of large welds is usually accompanied by extrusion of the nugget, which is evidenced by the irregular white outline of the extruded material. The dark ring is the only important radiographic indication of the extent of nugget bonding and of the strength of the weld. Failure to recognize and use this important feature of the radiograph, and overemphasis of the more prominent radiographic details, such as cracking and porosity, have actually led some observers to condemn spot-weld radiography as unreliable and worthless in spot-weld inspection.

The Radiographic Dark Ring and Spot-Weld Process Control

The radiographic dark ring is a useful guide to proper sheet preparation, suitable electrode tip conditioning and correct welding machine performance. The sharp dark line of normal diameter and circular shape, consistently repeated for weld after weld, is an excellent indicator of good spot-weld process control, both in material preparation and machine operation. Lack of symmetry, such as elongation of the dark ring, repeated consistently weld after weld, or growing more irregular as welding proceeds, is evidence of poor tip contour or bad tip surface condition. Irregular variations in the shape of the dark ring on adjacent welds indicate poor sheet surface preparation resulting in nonuniform surface conditions.

Tendencies of the dark ring to increase in diameter consistently as welding proceeds indicate increasing welding heat, which might be caused by slow drifting of the welder current control, or slow, consistent changes in sheet surface properties or tip condition. This condition should be corrected before oversize welds containing defects such as porosity, cracking, extrusion or expulsion have a chance to occur.

Tendencies of the dark ring to decrease in diameter, particularly if the dark ring simultaneously broadens, are a danger signal of decreasing weld energy and lowered weld strength. Such welds tend toward excessive Alclad inclusion, irregular strength consistency and occasional "dud" welds. This condition may result from slow drifting of the welder current control, low current settings or slow increases in tip pressure during welding. Correction should be made immediately upon detection

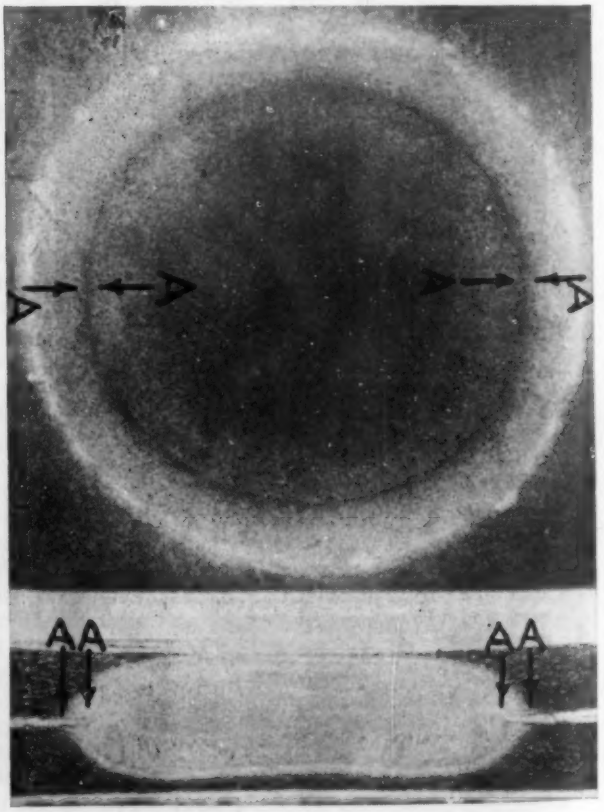


Fig. 8—Radiograph and Section of a Spot Weld with Large Nugget Diameter. 10 ×

The radiographic dark ring *A–A* outlining the weld nugget is of correspondingly large diameter.

of the tendency toward change in the dark ring diameter, before any understrength or defective welds can be produced.

Radiographic Indications of Cracking, Porosity, Expulsion and Extrusion

Voids in the region of a spot weld result in black images on the radiographic film. Voids produce high density images because X-rays pass through voids or gas pockets with far less absorption than occurs when X-rays pass through equivalent thicknesses of aluminum alloy. Since high contrast sensitivity is used for spot-weld radiography, voids usually appear intensely black on the radiograph, and can be readily distinguished from dark rings and other features resulting from local changes in the composition of the alloy.

Cracks in the weld nugget are revealed in the spot-weld radiograph by prominent, sharp black images, frequently radiating spokewise from the center of the weld nugget.

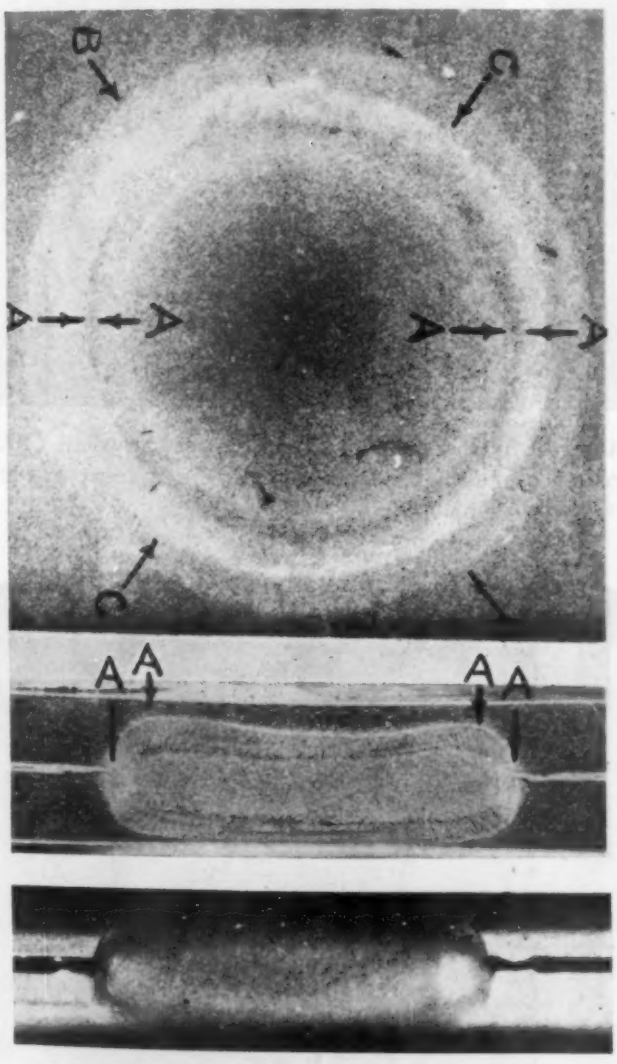


Fig. 9—Radiograph, Section and Section Radiograph of a Large Spot Weld with Very Little Alclad Inclusion Into the Weld Nugget at the Faying Plane. 10 ×

The radiographic dark ring *A–A* is broad because of the wide projection of the curved boundary between the nugget and the parent material.

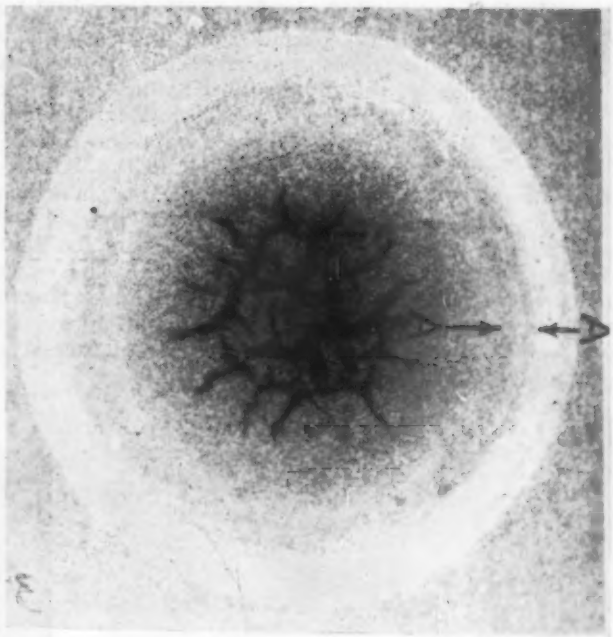


Fig. 10—Radiograph and Section of a Large Spot Weld in Whose Radiograph the Prominent Dark Ring *A–A* Splits Into Two Concentric Dark Rings. 10 ×

This occurs when the nugget has somewhat different diameter or shape in the upper and lower spot-welded sheets.

Thin cracks in the granular zone of the weld nugget near the faying plane are revealed, as in Fig. 15, by fine, single-line images. Large cracks extending throughout a significant portion of the sheet thickness or even to the sheet surface usually show broad- or multiple-line images. Such images are produced by the superposition of images of several parts of the crack, for deep cracks normally progress irregularly from the center of the weld outward toward the sheet surface. (Compare Figs. 16 and 21.) Welds containing cracks extending across most of the diameter of the weld nugget are easily differentiated from welds with only small cracks in the heart of the nugget.

Porosity in the weld nugget is revealed on the spot-weld radiograph by prominent, dull (rounded) black images, which may be located almost anywhere within the weld nugget. In many cases, the voids are at or include the faying plane. The size and number of the porosity indications, and their location with respect to the highly stressed regions of the weld nugget, determine their importance as structural defects. A typical example of small porosity indications is shown in Fig. 17. A large hole appears in the weld of Fig. 18.

Expulsion ("spit") at the faying plane of the spot weld is revealed clearly on the radiograph by a light image of the expelled material. Since expulsion increases the thickness of the material outside the weld nugget through which the X-rays must pass, the increased absorption in the additional material results in a light image on the

X-ray film. Expulsion indications are characterized by the typical shape of the "splashed out" material, which can be observed to correspond exactly with the shape of the expelled alloy at the faying plane (which is visible after the weld has failed in shear). A small expulsion is shown in Fig. 19, while more extensive expulsion, accompanied by cracks and porosity, is shown in Fig. 20.

Extrusion of the nugget at the faying plane, in which alloy from the weld nugget is pushed out between the sheets at the faying plane, is also revealed by the light radiographic image of the extruded alloy. The exact extent and the outline of the extruded material are shown by the irregular outer boundary of this light image, as shown in Fig. 21. Thus a frequent cause of excessive sheet separation is revealed by radiography.

Radiographic Cracking, Porosity, Expulsion or Extrusion, and Spot-Weld Process Control

Radiographic indications of cracking, porosity, expulsion and extrusion provide significant information concerning spot-weld quality and process control. Radiography reveals nugget cracking more sensitively than do sectioning and metallographic examination, since such sections often fail to pass through the plane of the nugget cracks.

Nugget cracking may be caused by excessive welding energy, poor sheet preparation, inadequate electrode force during welding and forging, improper forge time delay, or combinations of these and related causes. In many cases, all production welds made in certain gage

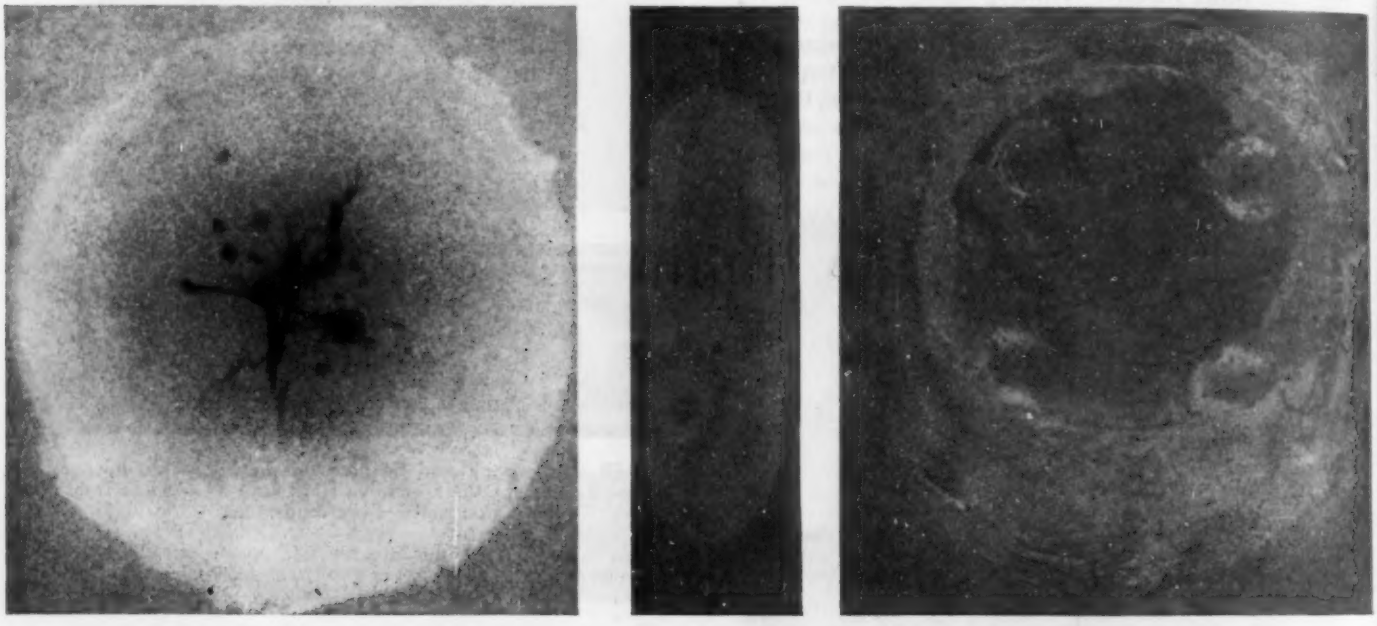


Fig. 11—Radiograph, Faying Plane and Section of a Large Diameter Spot Weld with Local Nugget Extrusion. 10 ×
In these locations there is no Alclad inclusion at the faying plane, cast alloy has extruded into the faying plane and the nugget boundary has little slope. As a result, the dark ring *A–A* fades into invisibility locally.

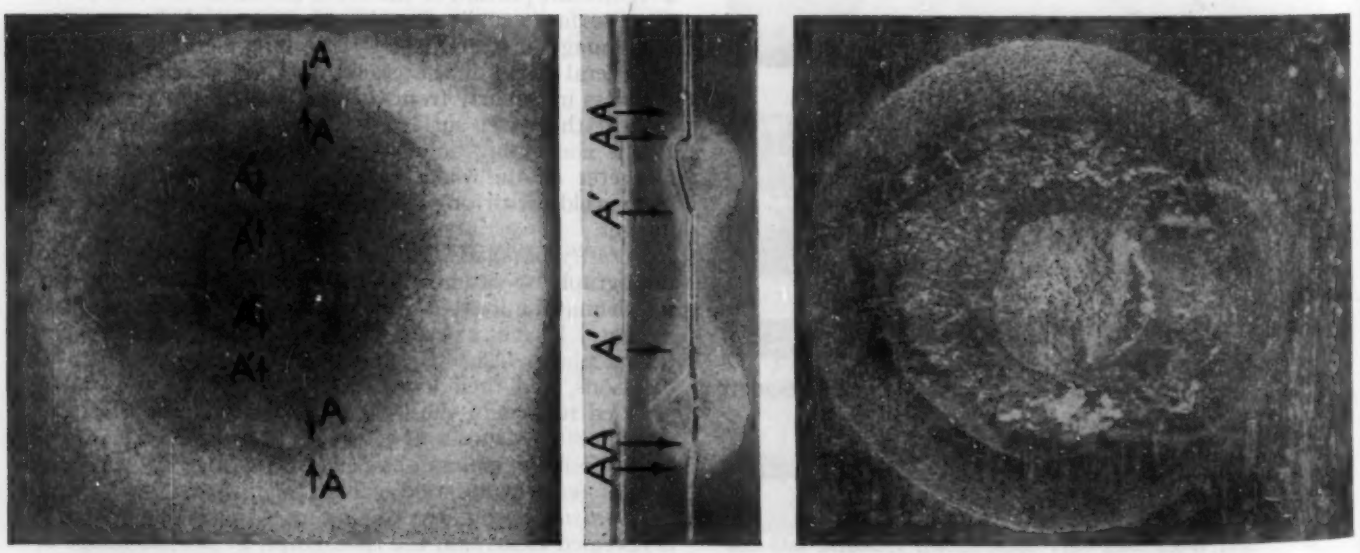


Fig. 12—Radiograph, Faying Surface and Weld Section (Reassembled After Failure) of a Spot Weld with a Doughnut-Shaped Nugget. 10 ×
Inner (*A'–A'*) and outer (*A–A*) radiographic dark rings outline the nugget boundary at the faying plane

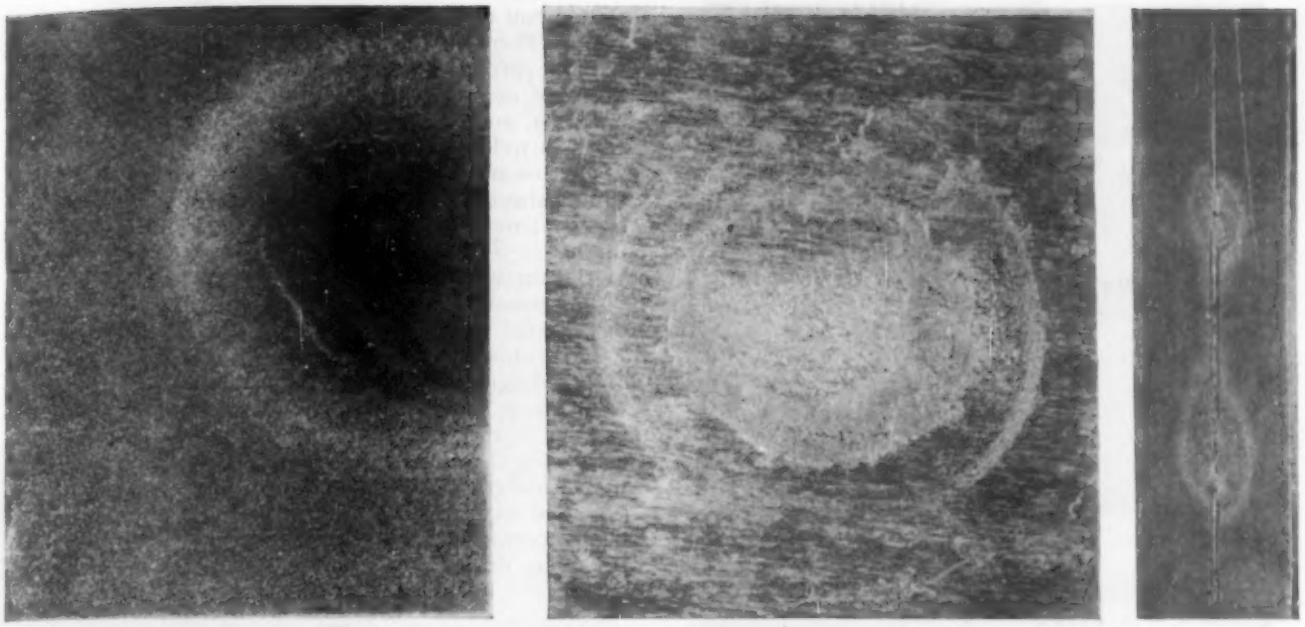


Fig. 13—Radiograph, Faying Surface and Weld Section (Reassembled After Shear Failure) of a Spot Weld with a Crescent-Shaped Nugget. 10 ×

The crescent-shaped nugget boundary at the faying surface is shown by the corresponding dark rings on the spot-weld radiograph.

combinations under routine machine set-up schedules in some aircraft factories showed nugget cracking under radiographic examination. These conditions usually occurred because spot-welding process control engineers had not previously had available a sensitive test, such as radiography, for the detection of nugget cracking. Many spot-welding schedules were accordingly set for the use of small tip radii and inadequate tip forces during welding and forging. Welding was often carried out at the edge, rather than in the center, of the range of machine settings producing acceptable spot welds in the particular gage combination. However, such continuous nugget cracking in production spot welds can be easily eliminated when spot-weld radiography is used in process control, for optimum machine settings can be ascertained much more sensitively by radiography than

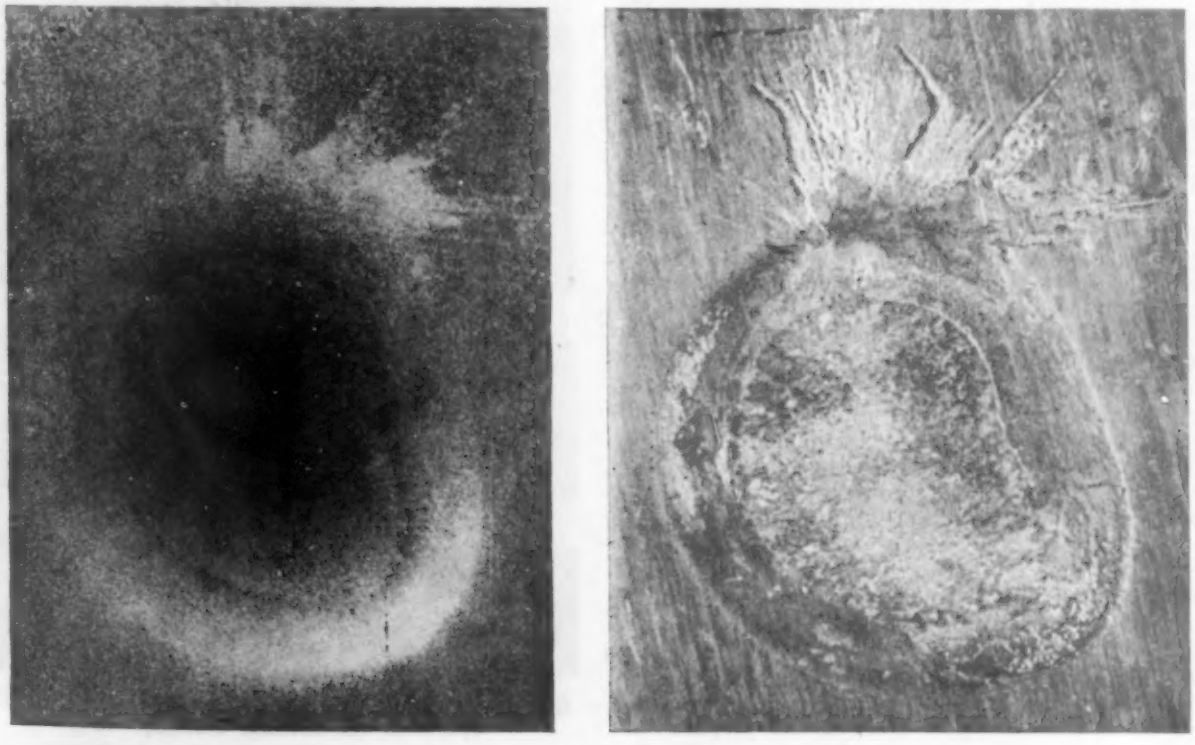


Fig. 14—Radiograph and Faying Plane of a Spot Weld with a Misshapen Nugget. 10 ×

The dark line on the radiograph follows faithfully the outline of the weld nugget.

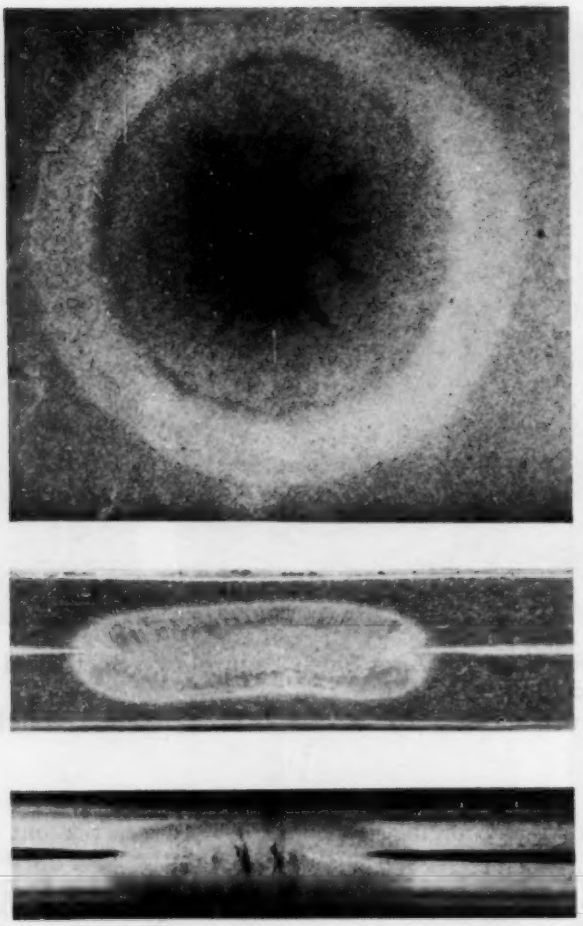


Fig. 15—Radiograph, Section and Section Radiograph of a Spot Weld with Fine Cracks Near the Faying Plane in the Center of the Nugget. 10 ×

The cracks shown clearly on the radiograph are usually difficult to observe on the weld section.

by shear strength measurements or section tests on coupons. The latter tests are relatively insensitive to the effects of cracks.

Intermittent nugget cracking, appearing irregularly in sequences of otherwise sound and acceptable spot welds, may be caused (*a*) by welding at the edge, rather than at the center of the acceptable operating range; (*b*) by irregular variations in machine performance, particularly in energy setting, forge force or forge-force time delay; or (*c*) by lack of uniformity in sheet surface preparation. The latter case can often be detected and distinguished from the other causes by accompanying irregular variations in nugget size and shape, as revealed by lack of symmetry of the radiographic dark ring *A–A*. Nugget cracking associated with poor tip contour or condition may often be recognized by the accompanying evidences of tip pickup (to be described later in this paper) or by nugget contours all similarly misshapen.

Porosity in the weld nugget is often associated with expulsion or extrusion of the nugget at the faying plane. Expulsion or extrusion is frequently caused by inadequate electrode tip radius or inadequate tip force during welding, so that the "hold-down" ring of force surrounding the nugget is inadequate to withstand the internal pressure of the molten material. Of course, excessive welding energy or poor sheet surface preparation may also cause expulsion with consequent porosity. In all of the preceding cases, porosity occurs because of the loss of material from the nugget region to such an extent that, upon cooling and freezing of the nugget, voids remain. Porosity may also occur, like nugget cracking, without accompanying expulsion or extrusion. Often porosity occurs simultaneously with excessive nugget cracking, and both can be remedied by the same corrections in welding procedure and machine settings.

Extrusion of the nugget at the faying plane, which causes sheet separation, is revealed far more sensitively by spot-weld radiographs than by other inspection methods. Often such extrusion occurs on only one side of the nugget, and cannot be detected or measured by visual inspection or feeler gage tests from the other side of the weld.

Laboratory tests reproducing these weld conditions, and radiographic checks of thousands of production welds made in aircraft factories with many types of spot-welding equipment revealed almost inevitably the same causes for the frequent appearance of production welds with radiographically detected cracks, porosity, extrusion and expulsion. Welding machines were generally being operated with inadequate tip radii and inadequate tip forces during welding and forging. Welding sched-

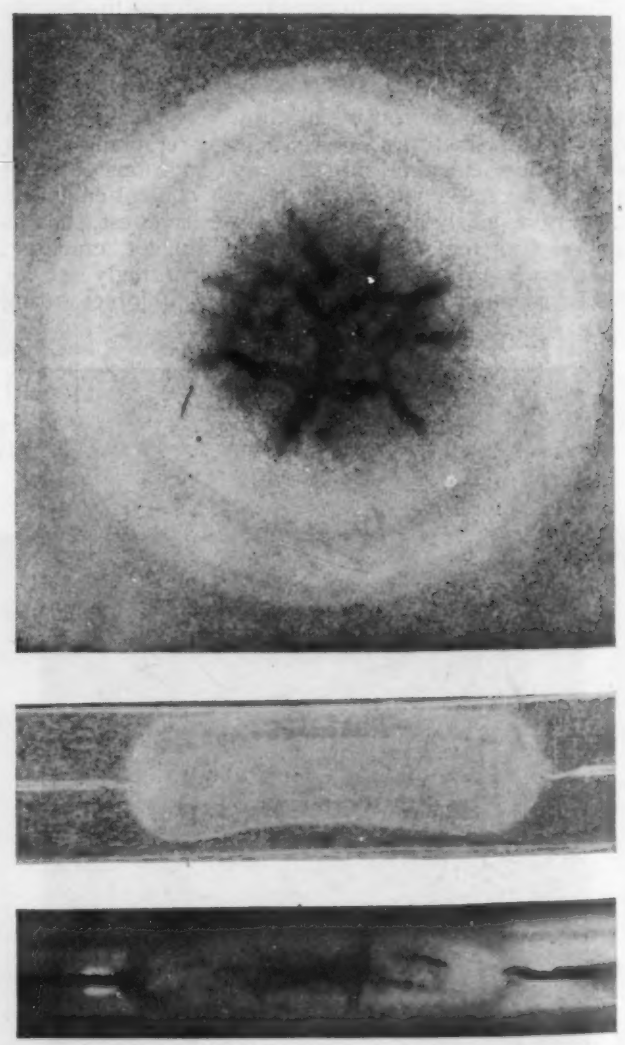


Fig. 16—Radiograph, Section and Section Radiograph of a Spot Weld with Extensive Cracking. 10 ×

Note segregation of eutectic under Alclad layer at faying plane just outside the weld nugget (visible in section radiograph as white area).

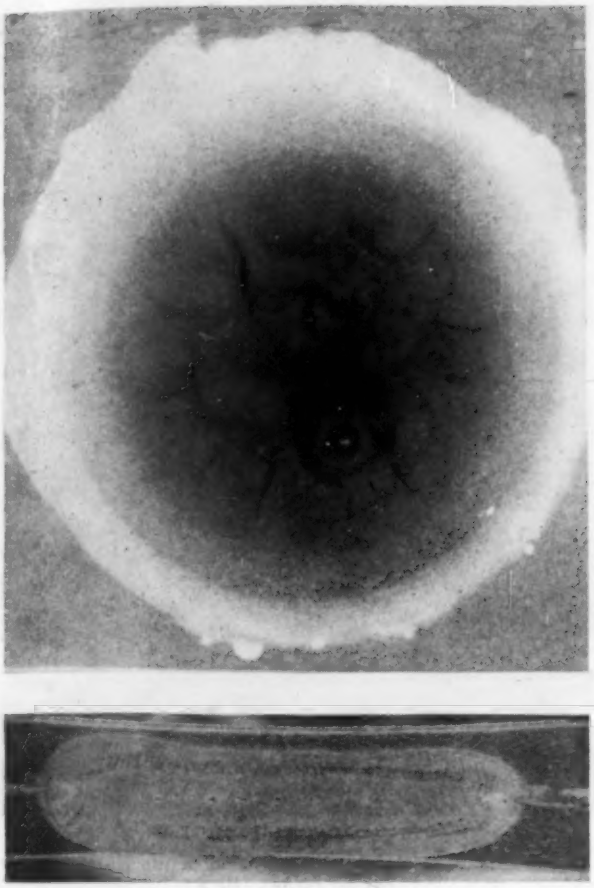


Fig. 17—Radiograph and Section Macrograph of a Spot Weld with Small Porosity Indications. 10 ×

Porosity is indicated by the small, dull (rounded) black images. Fine cracking is also present.

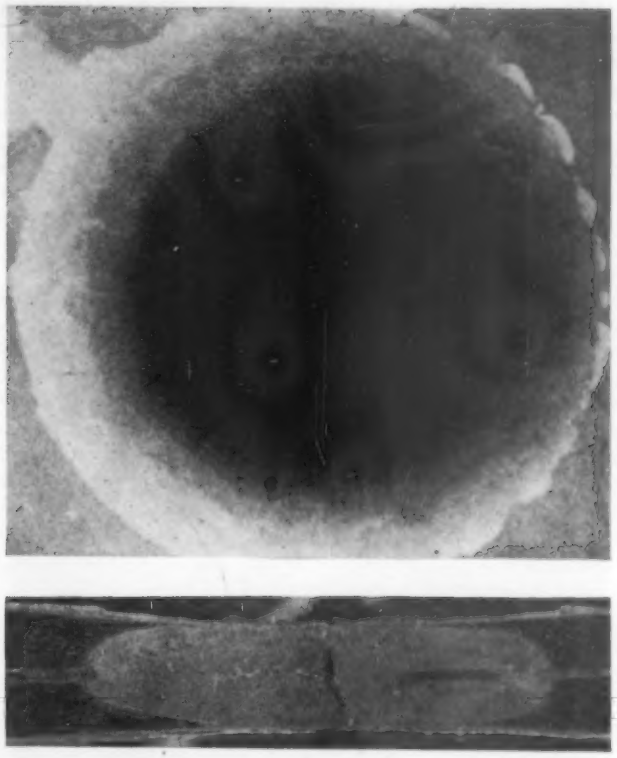


Fig. 18—Radiograph and Section Macrograph of a Spot Weld with Large Porosity Indications. 10 ×

Cracking, expulsion and excessive sheet indentation are also present.

ules established by shear test, sectioning and macrographic examination of spot welds were not sensitively determined, and such schedules were often set up to re-

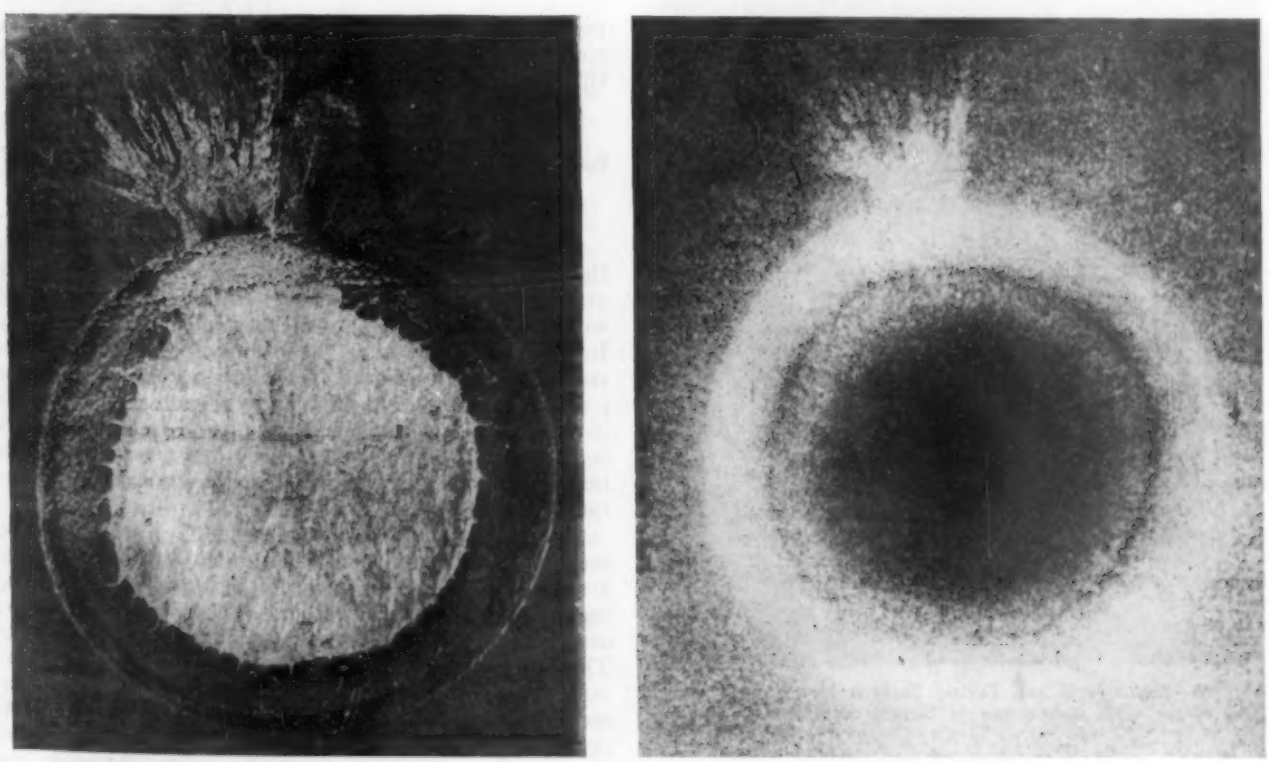


Fig. 19—Faying Surface Macrograph and Radiograph of a Spot Weld with a Small Expulsion ("Spit") Indication. 10 ×

The radiographic image corresponds exactly with the geometry and location of the expulsion.

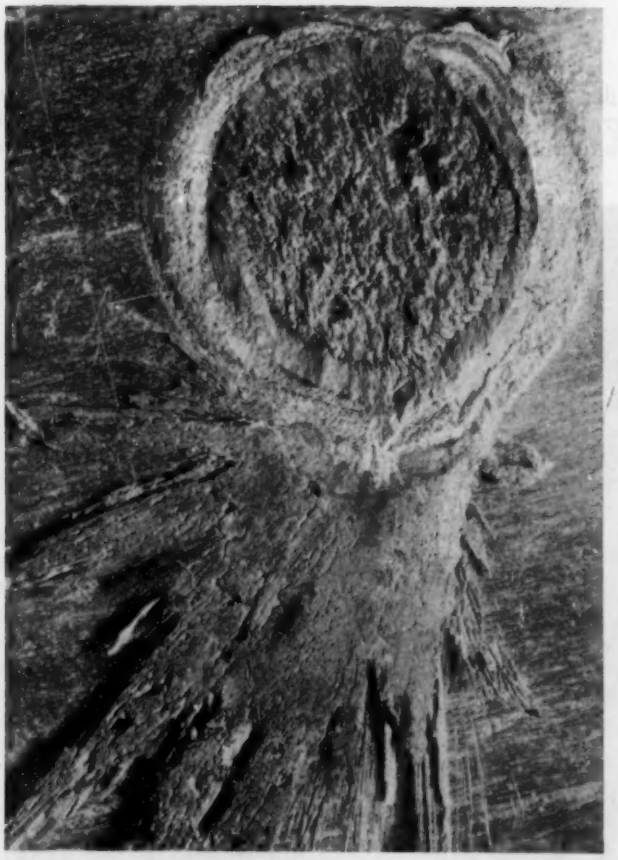


Fig. 20—Radiograph and Faying Surface Macrograph of a Spot Weld with Indications of Severe Expulsion ("Spit"). 10 ×

Cracking and porosity are also present.

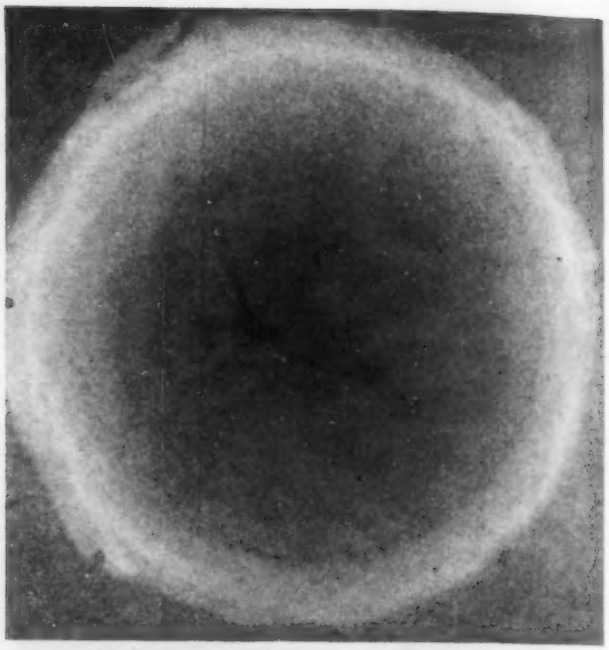


Fig. 21—Radiograph and Section Macrograph of a Spot Weld Which Has Been Subject to Extrusion of the Nugget at the Faying Plane. 10 ×

The radiograph shows an exact image of the extruded material. (Note also the multiple line image of the deep crack.)

quire welding under conditions far from the true optimum. The effort to qualify machines for the widest possible range of sheet thicknesses and gage combinations contributed measurably to the trend toward inadequate tip forces in production welding schedules.

Radiographic Indications of Segregation and of Structure

Segregation of radiographically dense constituents of the alloy as a consequence of welding produces radiographic indications which reveal structure within the weld nugget and incipient melting in the parent material. In regions *from* which the radiographically dense constituents have migrated, the alloy becomes more transparent to X-rays, and dark images, such as the dark ring *A–A* (previously described) result. In cases where the concentration of radiographically dense constituents has been increased, more X-ray absorption occurs, and light radiographic images are obtained.

The welding heat may cause extensive grain-boundary melting in the parent material outside the weld nugget, and in some cases the action of heat and pressure causes segregation of pools of eutectic (the low-melting temperature constituent of the alloy) just outside this region. These eutectic pools are radiographically dense and produce very light radiographic images. Figure 22 shows a section of 24S-T parent alloy including a typical eutectic pool. Figure 23 shows the radiograph, section macrograph and section radiograph of a spot weld made with excessive welding heat. At this low magnification (10 ×), the section macrograph does not reveal the eutectic segregation, but the section radiograph (made by passing

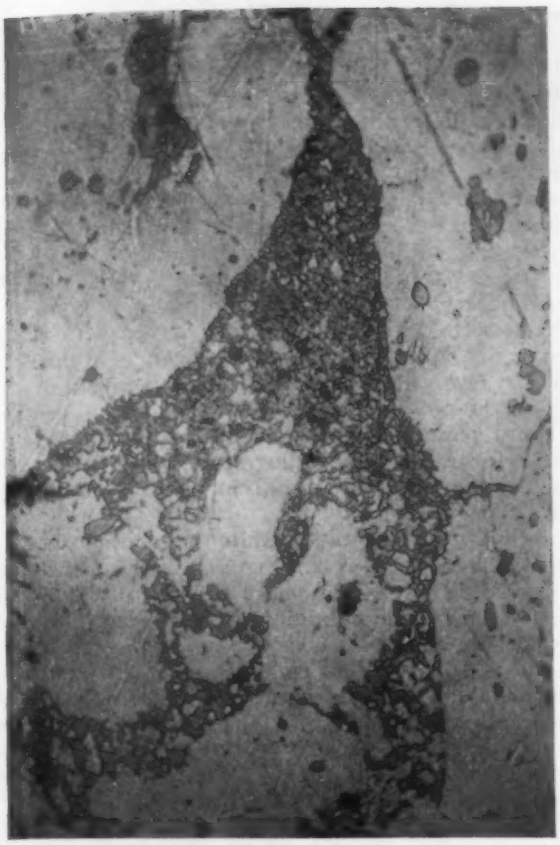


Fig. 22—Eutectic Pool in the Parent 24S-T Alloy Outside the Weld Nugget. 1000 ×

The pool is composed of radiographically dense eutectic material segregated under the heat and pressure of welding and forced along melted grain boundaries to a region well outside the nugget boundary region.

X-rays through a thin vertical slice of the weld) reveals by white streaks the location, extent and geometry of the segregation. The weld radiograph reveals by a *white ring C–C* (Fig. 9) the location and extent of segregation. The white ring *C–C* is located outside the dark ring *A–A* which delineates the nugget boundary. It may extend either inside or outside the boundary *B–B* of the corona region. The presence, location and prominence of this white ring are very sensitive indicators of welding heat, and will indicate increase of welding heat above normal before any other evidence of this condition occurs.

Another type of *segregation* revealed by the radiograph occurs *in the weld nugget*. Radiographically dense constituents segregate into channels or lines as the nugget freezes, apparently in the same manner as in any cast ingot. With nuggets of normal shape, these segregations are shown on radiographs as white radial streaks, often near the faying plane, as shown in Fig. 24. With doughnut- or crescent-shaped nuggets, the segregation often appears as a white arc or circular line centered near the axis of the toroid section, as shown in Fig. 25. Careful examination of the faying surface, after shear failure of the weld, frequently reveals corresponding markings in the cast alloy at the faying plane, as evident in Fig. 25.

The *granular zone of the weld nugget* appears on the radiographs somewhat darker than the surrounding dendritic zone, as shown in Fig. 3. The section macrograph of this weld confirms this interpretation of the weld nugget structure from the radiographic image.

There is as yet no reliable experimental evidence that radiographically observable differences in the cast structure of the weld nugget affect weld strength or quality in any way. In many cases, it has been observed that only slight further increases in welding heat or other minor changes in welding conditions were required to change from nuggets revealing extensive segregation of radiographically dense constituents to nuggets with cracking. In a few cases, nugget cracks were found whose extremities were apparently filled with the radiographically dense constituents.

Extensive segregation of eutectic in the parent material, when associated with excessive heat-affected regions in the parent alloy just outside the weld nugget, may denote weakening of the alloy in this region, where many failures occur both in static and fatigue loading. The white ring *C–C*, responding sensitively to changes in weld energy, makes a good detector of impending changes in welder performance, which, if not corrected, might lead to weld defects associated with excessive welding heat.

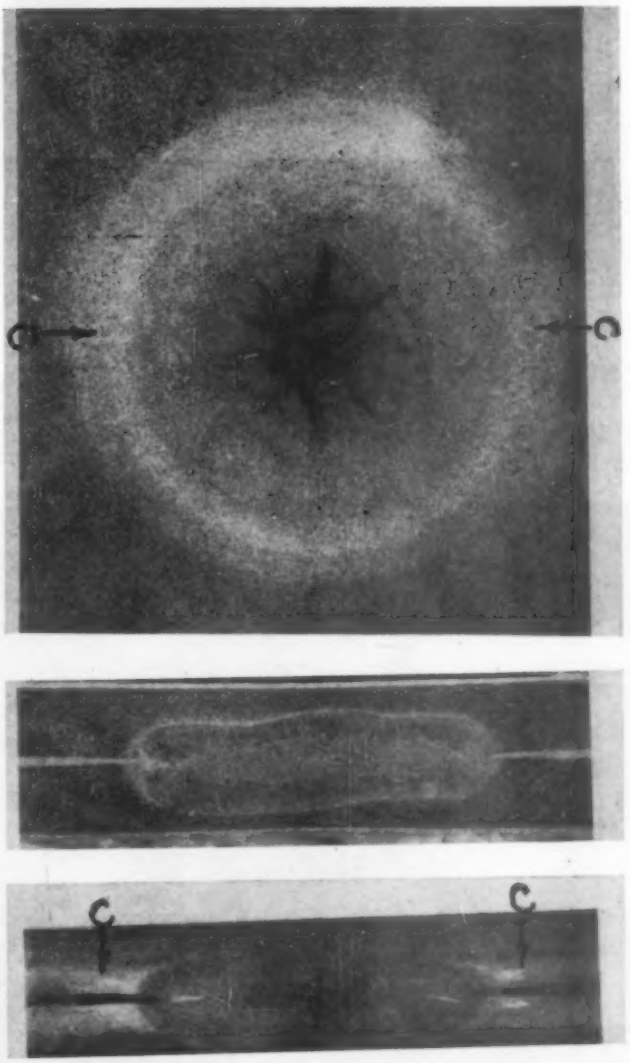


Fig. 23—Radiograph, Section and Section Radiograph of a Spot Weld with Segregation of Eutectic in the Parent Material. 10 ×

The radiograph shows by the white ring *C–C* the location and extent of the eutectic segregation (associated with welding heat) in the parent material.

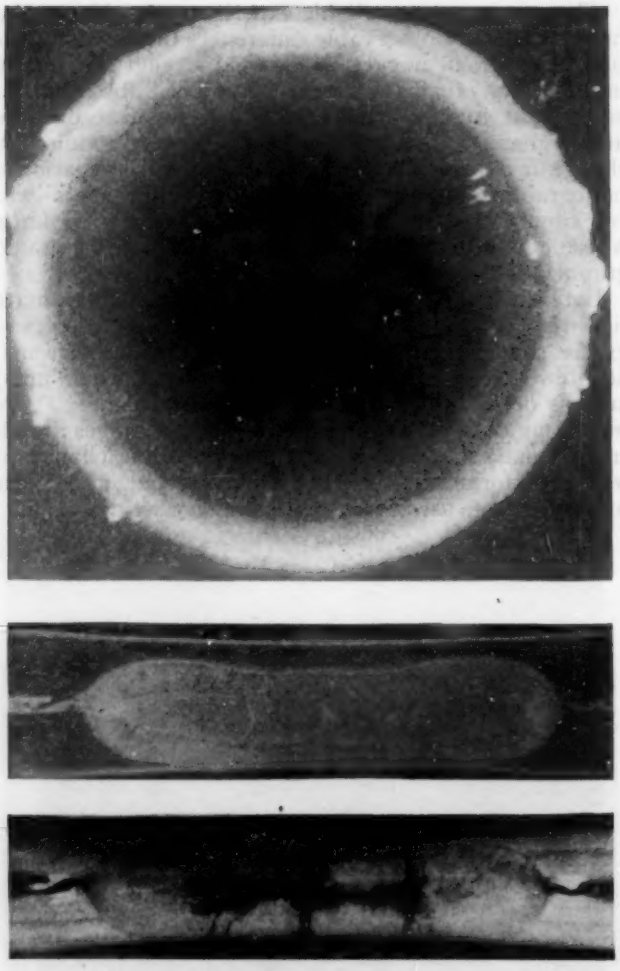


Fig. 24—Radiograph, Section and Section Radiograph of a Spot Weld Showing Radial Segregation of Copper-Rich Constituents in the Nugget. 10 ×

Section radiograph reveals the segregation to be near the faying plane.

Other Radiographic Indications

The spot-weld radiograph provides information concerning the "corona" region at the interface. In Alclad aluminum alloys, the term "corona" is usually associated with those areas of the Alclad layers at the faying surface which have been influenced by the welding heat and pressure. The light area between radiographic dark ring *A–A* and the outer boundary *B–B* of the light band in the radiographic image (Fig. 9) is produced by the effects of heat and pressure upon the Alclad material at the interface. The soft aluminum coating is pushed outward from the region of the nugget (as shown by the flow lines of Fig. 26) and increased in thickness in the corona region. The outer boundary *B–B* of the uniformly light area on the radiograph is a reliable indication of the extent and geometry of the "corona" region at the interface. However, the radiograph does not indicate whether the Alclad material in the corona region is strongly or poorly bonded.

Tip pickup may result in white radiographic images of irregular shape, as shown in Fig. 27. These white images are produced by the alloying of copper from the welding tips with the Alclad aluminum alloy being welded. The addition of copper makes the material locally more opaque to X-rays. Tip pickup takes place particularly at high welding energies as the welding electrode tips become dirty. Usually under these conditions the weld nugget (as a result of local heating where the electrodes contact the sheet surface) grows outward nearly to the sheet surface, approaching 100% penetration. The alloying takes place near the sheet surface in contact with the welding electrode tips, as shown by the cross-section macrographs of Fig. 28. By etching the outer surface of the spot-welded sheet with Keller's etch, the geometry of the areas of alloying is made evident. Figure 27 shows that these areas revealed by etching correspond exactly to the white images on the radiograph. Figure 29 shows radiographs of a series of consecutive production spot welds made at high energy, from one tip cleaning through successively worse conditions of tip pickup to the next tip cleaning. The continuous increase in tip alloying is clearly evident on the original radiographs.

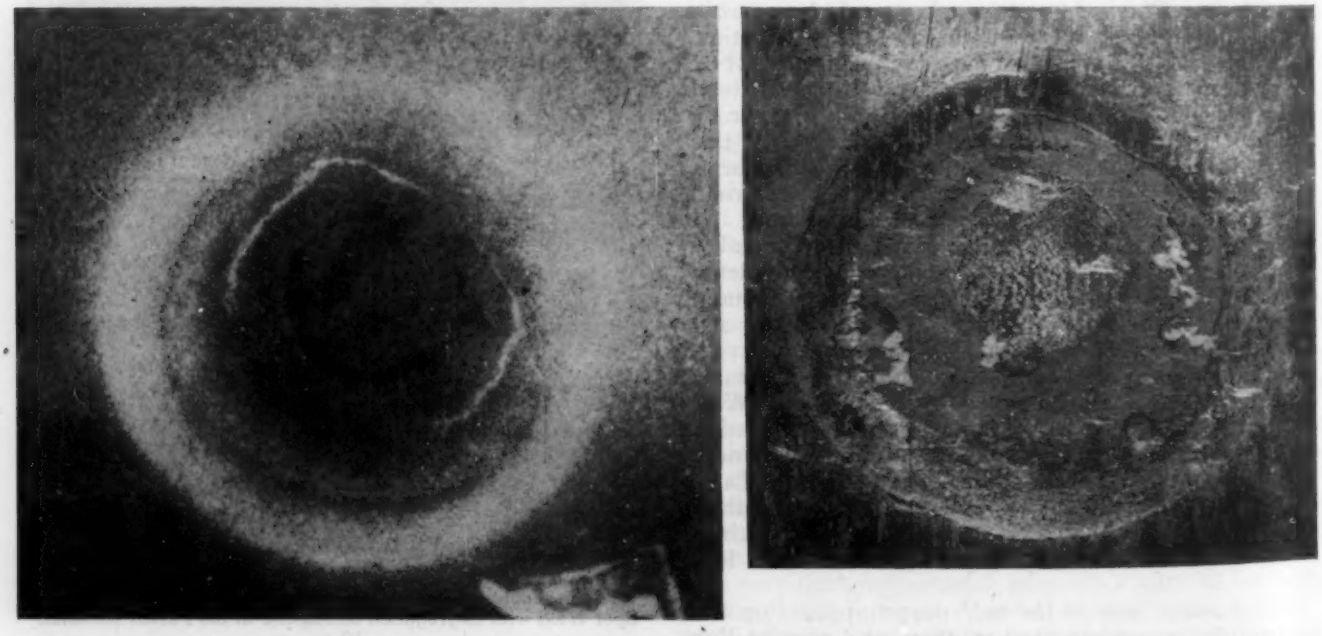


Fig. 25—Radiograph and Faying Surface Macrograph of a Doughnut-Shaped Spot Weld Showing Circular Segregation of Copper-Rich Constituents in the Nugget. 10 ×

Faying surface shows corresponding patterns locating the segregation near the faying plane.

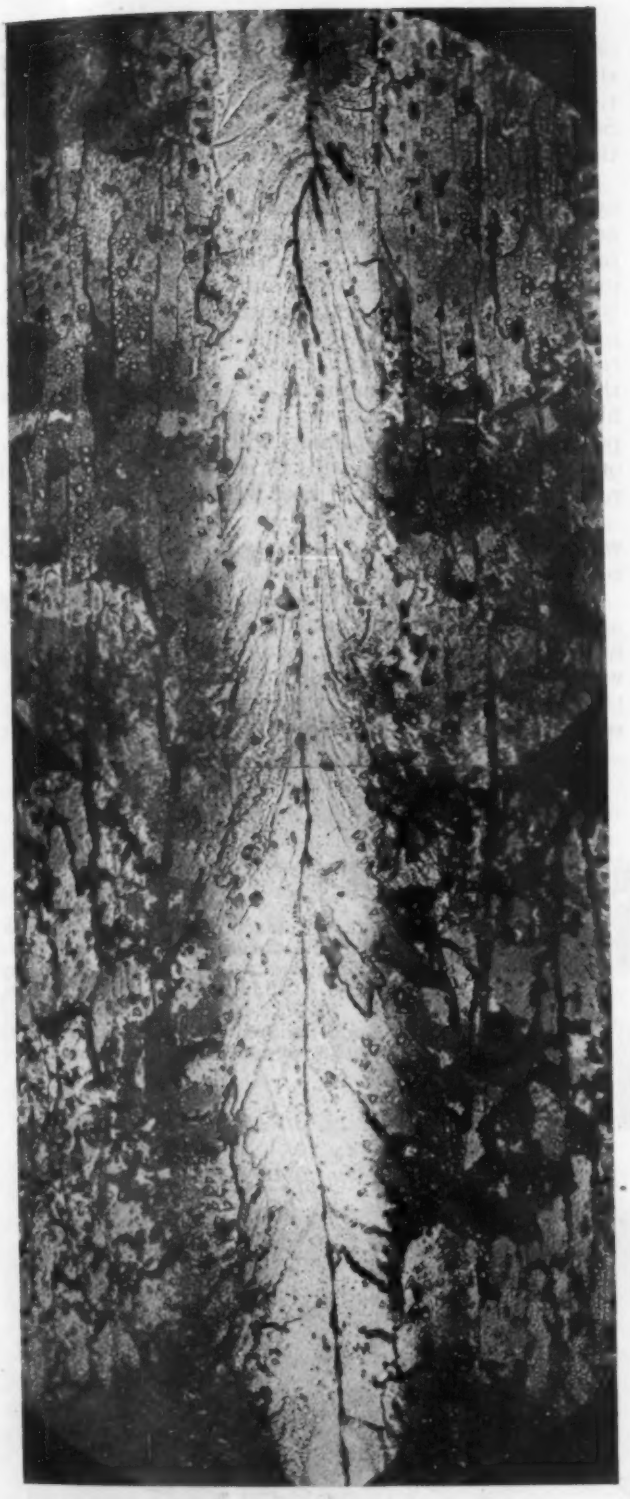


Fig. 26—Flow of Alclad Material at the Interface of a Spot Weld in 0.040-0.040-In. 24S-T Alclad Aluminum Alloy Sheets. 200 ×

As a result of the displacement of soft aluminum cladding material outward from the weld nugget (at the top), the material thickness is increased in the Corona region, and the radiograph reveals the boundary *B–B* of the "Corona" ring.

Partial expulsion at the interface (which may or may not be accompanied by evidence of "spit") may introduce unsymmetrical white areas in the corona ring between the dark ring *A–A* and the corona outer boundary *B–B*, as shown in Fig. 30. Here nugget cast alloy material has spread out locally in a thin layer over the corona ring at the interface. This film of alloy expelled from the nugget increases the X-ray absorption and produces a light image of the area affected. Such partial expulsion may be caused by tip skid or by inadequate "hold-down" pressure during welding.

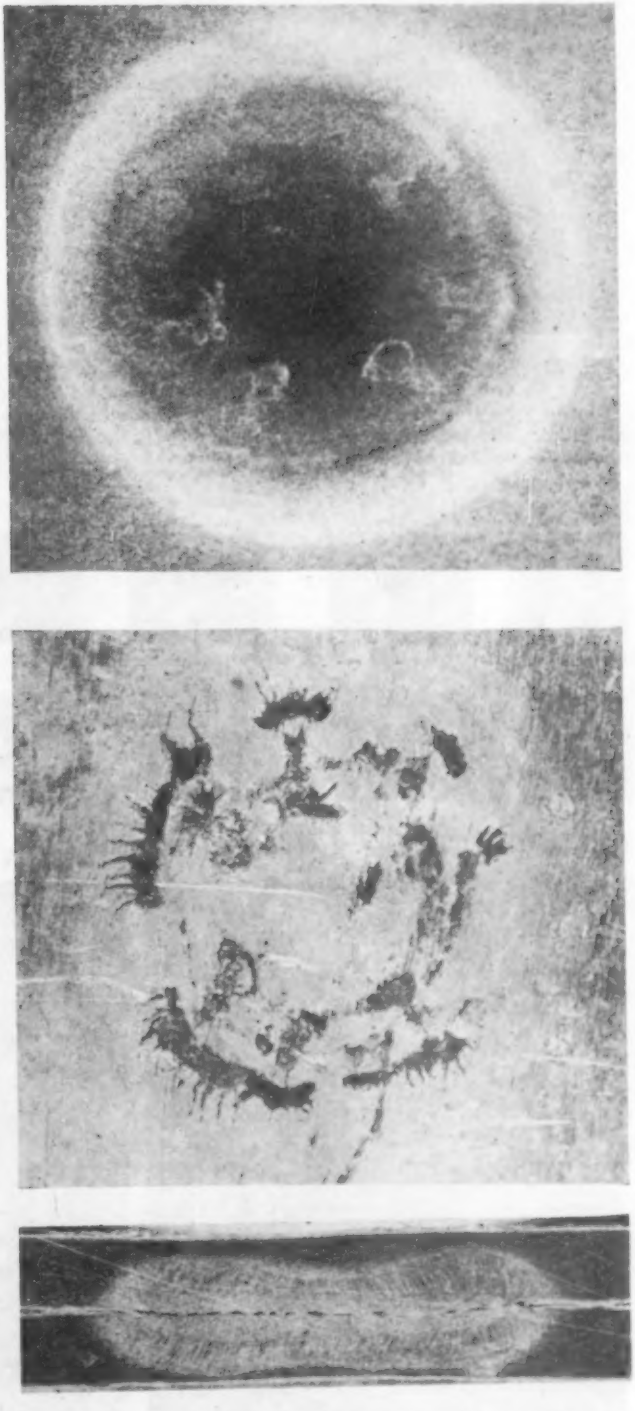


Fig. 27—Radiograph, Outer Sheet Surface Macrograph and Section Macrograph of a Spot Weld, Showing Tip Pickup. 10 ×

Etch reveals that the copper alloy of the welding electrode tip alloyed with the material of the welded sheet. The radiograph reveals the pattern of the deposited copper.

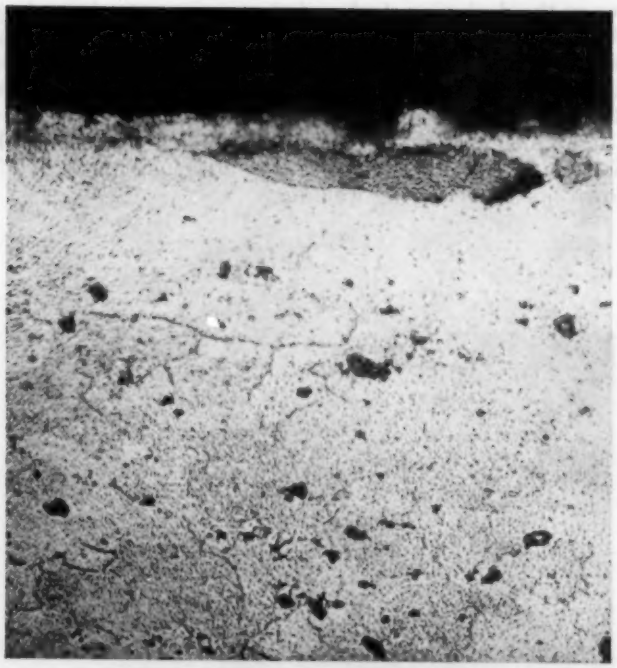


Fig. 28—Vertical Section Through a Spot Weld Which Has Been Subject to Tip Pickup. 500 ×

The dark pool visible just below the outer surface of the sheet results from alloying of the copper tip material with the aluminum alloy of the welded sheet

Tip skid may also push up a ridge of Alclad material on the outer surfaces of the welded sheets, the ridge being shaped in accordance with the contour of the skidding tip. It may produce a thin white arc on the radiograph. Such indications should be checked by visual examination of the surface of the welded sheet.

Inclusions of foreign matter at the interface or on the outer faces of the welded sheets will affect the radiographic images if the radiographic density of the foreign material is adequate. Particularly, paint or metallic inclusions may appear very prominently. For example, the identifying numbers appearing so clearly on the radiographs of Fig. 29 are images of identifying numbers *rubber stamped with printers' ink** upon the surfaces of the spot-welded aluminum alloy sheets away from the film. Uniform, thin layers of radiographically transparent materials (i.e., primer) will not usually be visible on the radiographs, and will not interfere with or prevent radiographic inspection of spot welds.

Scratches, dents and marks on the surface of the spot-welded material which change its thickness produce corresponding radiographic images.

Unusual radiographic indications should be checked against the welded material itself in every case before interpretations are made. No interpretation concerning weld quality should be made unless proof of the correlation between the unusual radiographic indication and the weld property is obtained by destructive test or by the

* Western Electric Co. Vermillion Printers' Ink No. 1318.

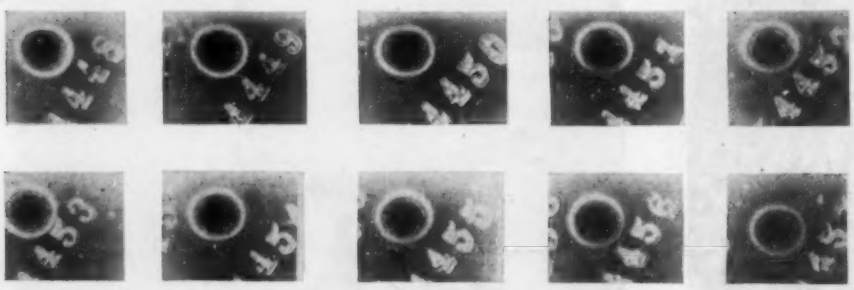


Fig. 29—Contact Reproduction of Radiographs of a Consecutive Series of Production Spot Welds Made with High Energy in 0.040–0.040-In. 24S-T Alclad Aluminum Alloy Sheets, from One Tip Cleaning Through Successively Worse Conditions of Tip Pickup to the Next Tip Cleaning. 1 ×

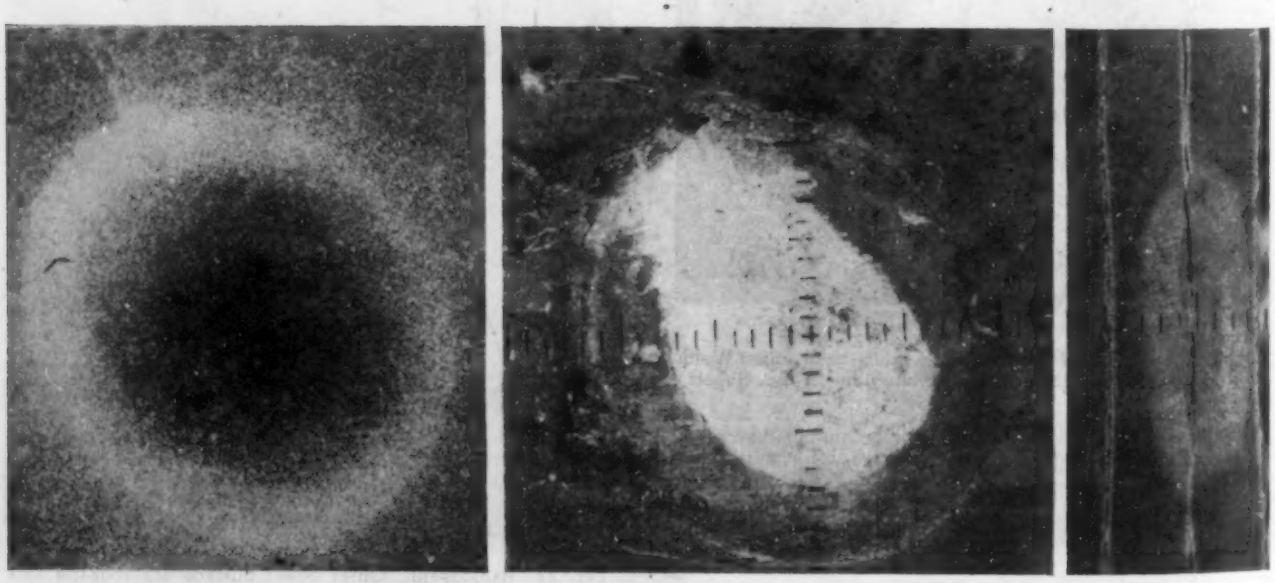


Fig. 30—Radiograph, Faying Surface Macrograph and Section Macrograph (Reassembled After Shear Failure) of a Spot Weld Which Has Been Subject to Partial Expulsion at the Interface. 10 ×

Nugget cast alloy has spread in a thin layer over part of the corona ring, producing an unsymmetrical white image in the radiograph.

sectioning of the particular weld specimen, followed by careful direct comparison of the weld with the radiograph.

Conclusions

The large number of significant spot-weld properties, and the sensitivity with which they are revealed and measured, makes spot-weld radiography a more useful nondestructive test method for spot-weld inspection and quality control than any other method so far developed.

Since radiographic inspection indicates the strength and quality of spot welds in the actual *production structure*, rather than in test coupons (which are not influenced by adjacent spot welds, poor fit, and surface conditions which affect spot-weld quality in the production parts) it provides more reliable spot-weld control than static testing of such test coupons. In addition, radiography is a more sensitive indicator of variations in welding conditions than static testing of spot-weld coupons. With radiographic spot-weld process control, it is possible to adjust welding equipment to operate more nearly in the center of the optimum range, for each material and gage combination. With such adjustment, wider variation of welder performance can be tolerated without the production of defective welds. Furthermore, any tendency toward variation in operation of the welder can be detected and corrected by the use of radiography, before welds that are actually defective have been produced.

The methods of interpretation presented in this paper provide a complete analysis from radiographs of the significant properties of spot welds in two-layer, equal thickness combinations of Alclad 24S-T and 75S-T aluminum alloy sheets. The recent inclusion of the illustrations and text of the original report presenting these data in specifications* covering the spot welding of naval aircraft will provide an opportunity for further checking and extension of these principles of interpretation, under production spot-welding conditions.

Acknowledgments

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13. General Electric X-Ray Corp., Chicago, Ill.
14. Westinghouse Electric Corp., X-Ray Div., Baltimore, Md.
15. Machlett Laboratories, Inc., Springdale, Conn.

* Navy Department, Bureau of Aeronautics Specification Navaer PW-6a Amended, for "The Spotwelding of Aluminum and Aluminum Alloys."

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Fusion Welding of Sheet Metal*

By J. M. Diebold†

WITH the ever-increasing emphasis on lightness and rigidity in new production design, sheet metal is becoming more and more a structural material of first importance. Even now there are appearing new structural beams out of light-gage material fabricated into sections of various sorts and designed to replace a lot of the lighter structural steel shapes used heretofore. This material is already starting to replace wooden beams in domestic construction as well as in industrial use, as can be noted in some of the new housing literature. Because a great deal of information has already been made available on aluminum and magnesium fabrication in recent months, discussion has been confined to sheet steel and more specifically to mild sheet steel, since most of the applications of light-gage material depend on its rigidity as a controlling factor instead of its yield strength. As Detroit and the automotive industry have been synonymous for a number of years, many of the other manufacturing processes in this district have been influenced to such an extent that Detroit might be called a "sheet metal" town. Furthermore, because of the mass production nature of most of our fabrication, this assembly work has been done mostly with resistance welding and those few joints which would not lend themselves to this form of welding were neglected. Gas welding has been nearly always resorted to in these few cases, and for purposes of exterior finish the joints were subsequently depressed and the notch filled in with solder. Since the war, however, the following factors have revised the automotive thinking considerably along these lines:

1. An increasing consciousness of fusion welding possibilities gained during wartime contracts.
2. Experience with high quality precision manufacture with welding.
3. The ever-increasing expense and difficulty in the use of solder in connection with these joints.
4. Necessity of more and better finished joints.

Some of the recent additions to fusion methods give quite a selection of different fusion welding processes which are available for sheet metal fabrication and which are familiar to all of us. However, each of these processes will be reviewed briefly for purposes of comparison.

1. Gas Welding

Since gas welding is the oldest form of fusion welding, aside from blacksmith practices, procedure details are well known and therefore will not be discussed at this time. Advantages found in the use of this process are as follows:

(*a*) This process is more universally understood and practiced than any other.

(*b*) Experienced operators are nearly always readily available and therefore training programs can be held to a minimum.

(*c*) Very fine or delicate work can be welded with proper equipment.

(*d*) Slag removal is not necessary.

(*e*) Relative cost of equipment, both manual and automatic, is inexpensive.

It has, however, the following disadvantages:

(*a*) The process is relatively slow and therefore expensive, since the chief cost of welding is labor. Relative speed on 20-gage steel is not more than 6 in. per minute.

(*b*) This process gives a larger heat-affected zone

* Presented before February Meeting, Baltimore Section, and April Meeting, Milwaukee Section of AMERICAN WELDING SOCIETY.

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Fig. 1—The Completed DUKW Ready for Shipment

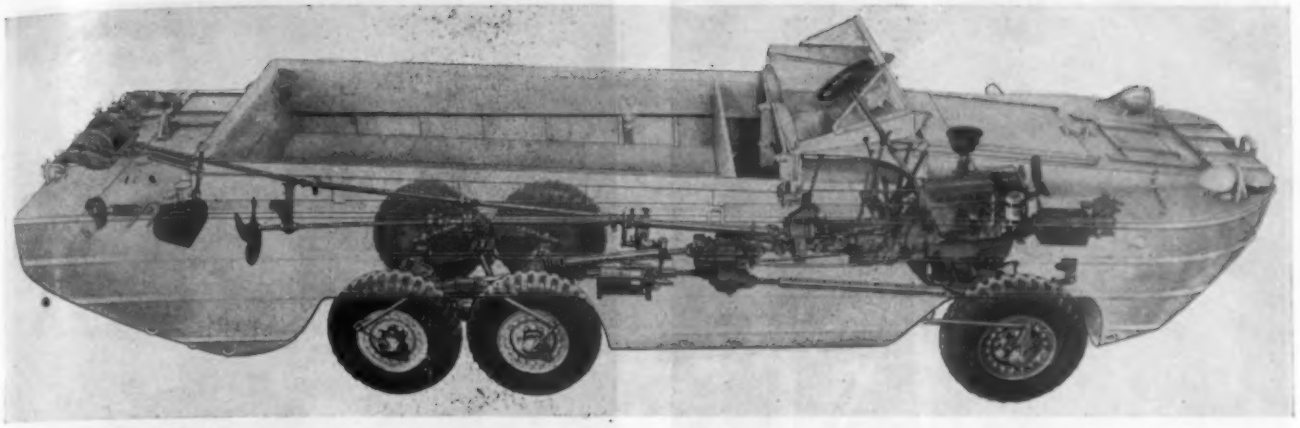


Fig. 2—Skeleton of DUKW Showing Power Plant and Running Gear Location

than most others, with resultant annealing of the stock and greater tendency toward buckling.

(*c*) Buckling plus necessary oxide removal and a rather irregular bead formation give a poor condition for finishing.

(*d*) Manipulation of the torch and the filler rod requires both hands to weld at all times.

(*e*) Position welding is difficult and not too practical for production work.

(*f*) Automatic welding is very limited as there is no automatic method of compensating for distance between flame and work.

2. Atomic Hydrogen Welding

This process, although widely used, has been confined chiefly to maintenance work and special applications which other processes cannot successfully weld. As the name implies, the heat is carried to the work by dissociated hydrogen, which has been changed to atomic form by the heat of the arc between the two tungsten electrodes. The hydrogen also acts as a shield, preventing oxidation during welding. It offers the following advantages.

(*a*) The finished appearance is quite good, as the bead is quite smooth and uniform. Only superficial oxides are formed which do not require cleaning after welding.

(*b*) It is capable of welding difficult materials not ordinarily welded by other processes.

(*c*) The heat-affected zone is much more localized than with gas welding.

(*d*) Power consumption is quite low, requiring only 12 to 15 amp. at 55 v. for the welding of 20-gage material.

It does have the following disadvantages:

(*a*) Although faster than gas, it is relatively slow and therefore expensive. On straight butt joints of 20-gage material, using a back-up strip, speeds up to 12 in. per minute may be expected.

(*b*) Manipulation of the electrode holder is rather awkward, especially in corners and places difficult to reach. Like gas welding, it usually requires the use of both hands because of the addition of filler metal.

(*c*) Although automatic application of this process improves the speed condition somewhat, its use automatically is limited by the fact that no control can be obtained to adjust electrode's position in relation to the work. It therefore requires exceedingly careful tooling.

(*d*) While this process can be used for position welding, it is difficult and therefore should be confined to work in flat position only.

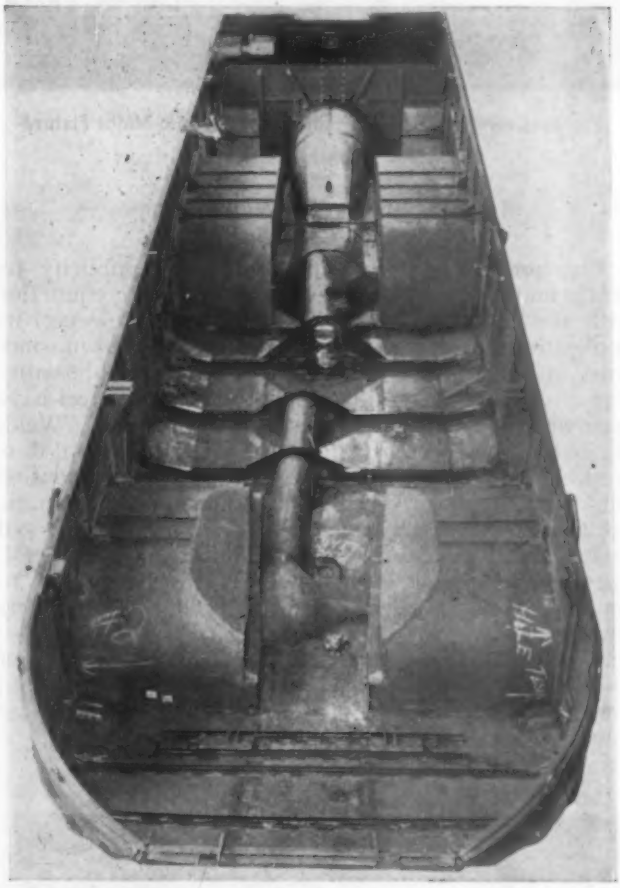


Fig. 3—View Showing Interior of Completed Hull Showing Complicated Floor Structure

Fig. 4—Lifting Eye Arrangement on Hull

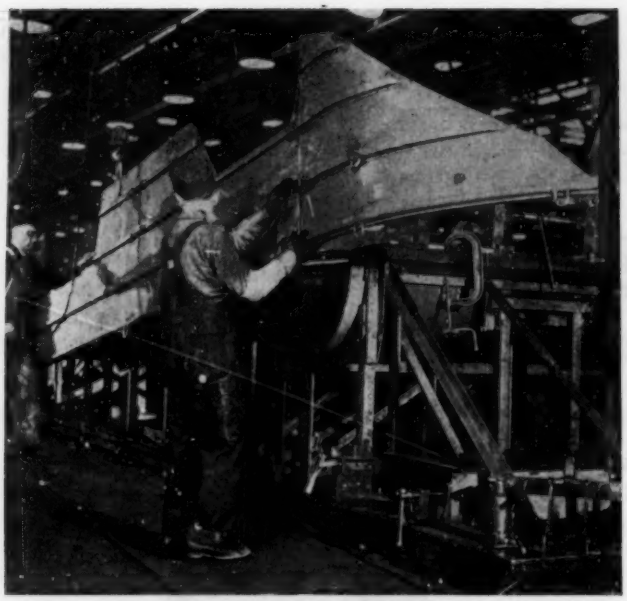


Fig. 5—Lowering Finished Side Assembly Into Major Fixture

3. Inert Gas Welding

This process has received considerable publicity recently under the name of Heliarc Welding in conjunction with the fusion welding of magnesium. However, its application to other material is not so well known, since most of the work to date has been on the laboratory basis. Aluminum, various copper alloys and steel have been welded with good success with this process. Welding of steel has been accomplished with a standard d.-c. arc-welding machine, using straight polarity at about 60 amp. for manual work, and about 110 amp. on automatic work for 20-gage mild steel. The equipment is light and compact, and while it requires the addition of filler metal, since the electrode is tungsten, it is even easier to manipulate than a gas welding torch. Some of its advantages are:

(*a*) It is much faster than gas welding, and speeds of 18–20 in. per minute have been obtained on 20-gage mild steel butt welds with manual operation, while automatic operation has given speeds up to 50 in. per minute on the same type of joint.

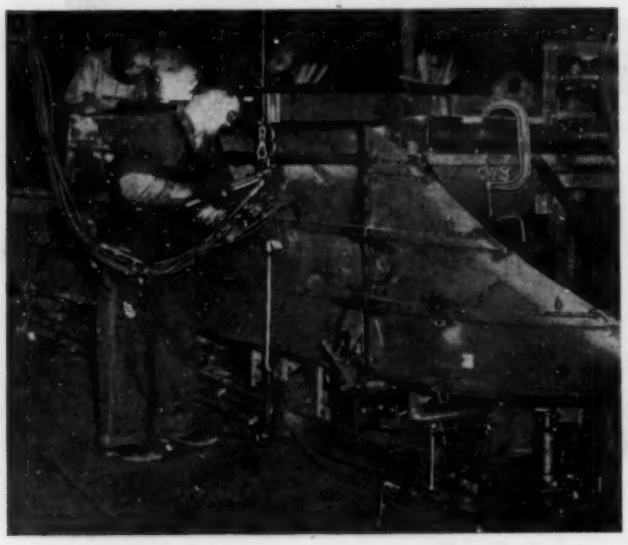


Fig. 6—Spot Welding Side to Bottom Assemblies

Fig. 7—Arc Welding Started as Spot Welding Progresses

(*b*) The finish appearance is excellent, particularly with the automatic process. The bead is smooth and free from oxides, and uniform in cross section.

(*c*) The heat-affected zone is narrower than either of the processes previously mentioned, resulting in less buckling and metal finishing.

(*d*) Process lends itself very well for exceptionally fine work.

It has, however, the following disadvantages:

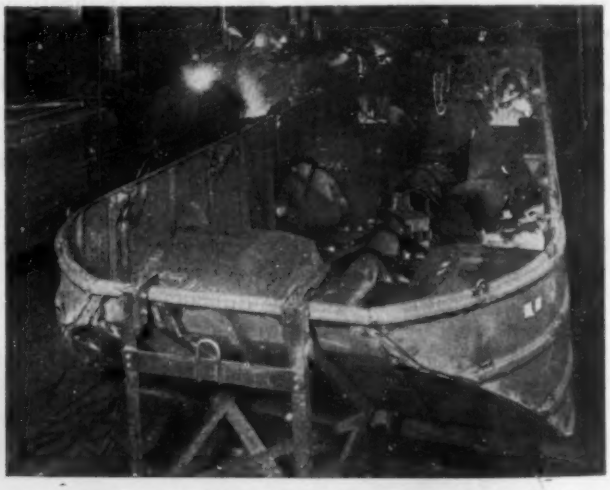


Fig. 8—Hull Turned Upright Showing Inside Sealing Welding

Fig. 9—Welding on Special Equipment Items on Final Assembly Line

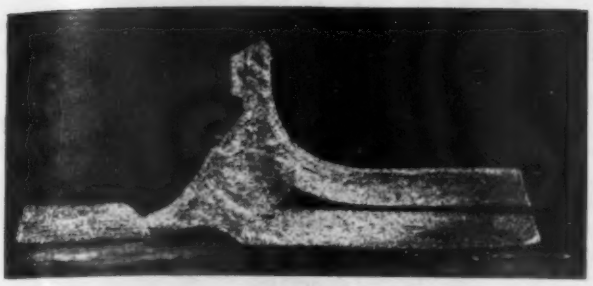


Fig. 10—Section of 16-Gage Weldment Showing Slight Undercut Can Be Dangerous

(*a*) This equipment is still in the experimental stage for many of its applications.

(*b*) So far as is known all automatic welding attempted has been experimental.

(*c*) While better adapted to position welding than the two previous processes, it is still recommended for flat and horizontal work only.

(*d*) In most types of joints it still requires the use of both hands for manipulation of the electrode holder and the filler metal.

4. Submerged Melt Welding

This process is considered practical only when used automatically and heretofore has been associated with materials of heavy gage. Recent applications, however, have demonstrated the ability of submerged melt to weld sheet thickness as thin as 18 gage in a practical production manner, and the 20-gage work looks promising. The characteristics of this method are well known and they carry over into sheet metal welding as well. Following are the main advantages:

(*a*) This process is very fast for production fabrication. Speeds up to 300 in. per minute have been used successfully on a number of different types of assembly.

(*b*) Its automatic operation is as successful as any and offers the advantages of uniformity and lower labor cost.

(*c*) It is not nearly as expensive to install or tool as resistance flash welding on relatively long joints.

(*d*) The weld quality is very good and readily reproducible, and presents an excellent surface appearance.

(*e*) It has excellent slag removal characteristics.

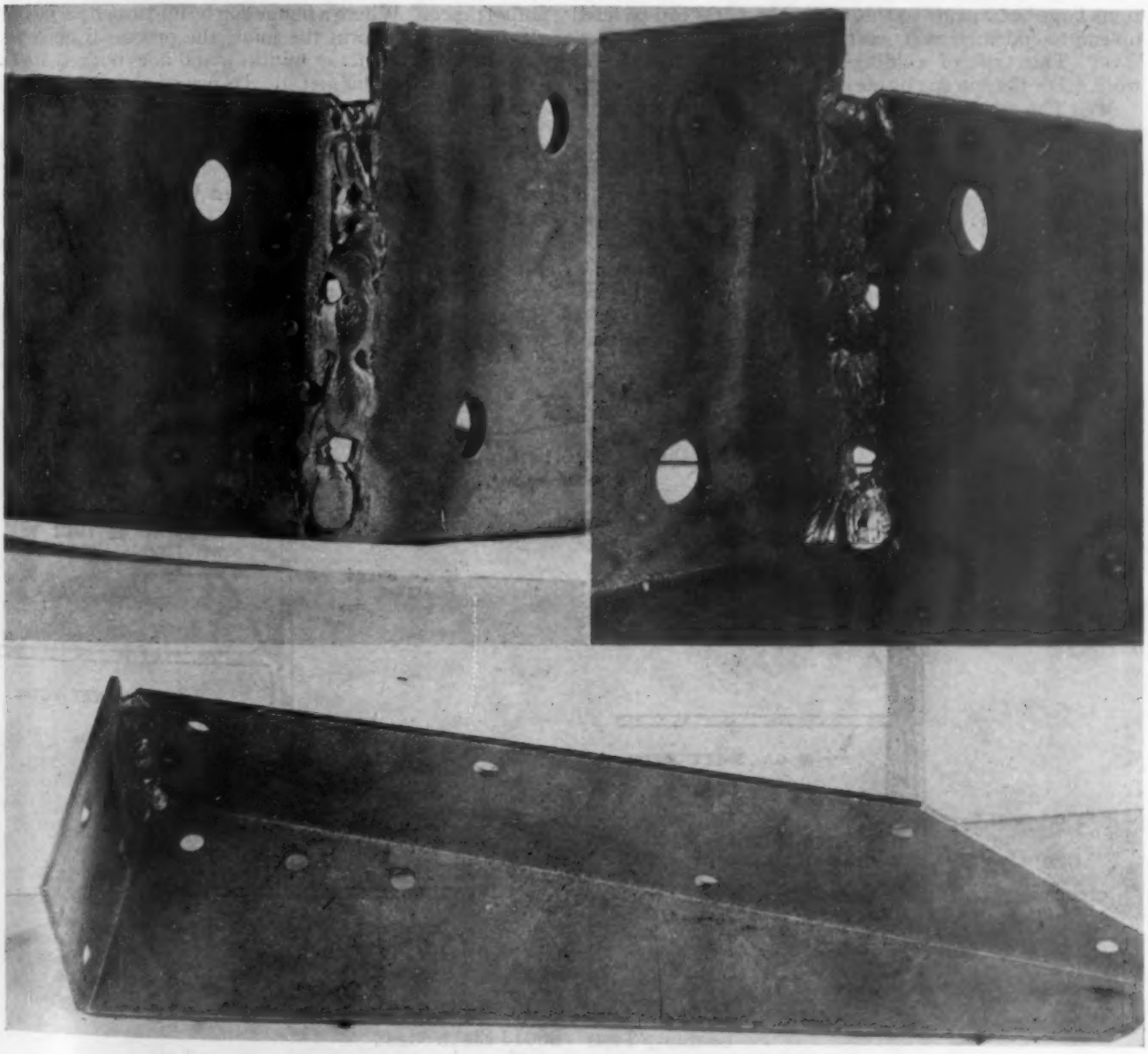


Fig. 11—Example of Welding with Average Operator and Wrong Type Electrode

Table 1—Comparison of Various Kinds of Fusion Welding, 20-Gage Butt Joint

Kind of Welding	Type Operation	Speed, In. per Min.	Position	Volts	Amp.	Back-Up	Slag Removal
Gas	Manual	6	F	..	...	Not necessary	Oxide removal
	Automatic	*	F	..	...	Clamping desirable	
Atomic hydrogen	Manual	12	F	55	15	.....	None
	Automatic	20*	F	..	...	Not necessary, but desirable	None
Inert Gas	Manual	20	F	25	60	.....	None
	Automatic	50	F	25	110	Not necessary, but desirable	None
Submerged melt	Automatic	300	F	22	250	16-gage butt strap	Good
Carbon arc	Automatic	60	F	20	175	Turned up flange	Oxide removal
Automatic arc welding	Automatic	60	F	20	175	Copper back-up or butt strap	Poor
Manual arc welding	Manual	24	F, V, OH	25	120	Butt strap best, back-up possible	Fair

* Much higher speeds with multiple heads but very restricted use.

It has, however, the following disadvantages:

(*a*) As the equipment is large and bulky, it is difficult to reach confined places and to follow intricate contours.

(*b*) Because of rather long set-up times, it is not usually practical for short joint welding. Some exceptions have been made to this where the parts can be lined up end to end such as generator housings.

(*c*) This type of welding is not at all adaptable for work other than in flat or horizontal position.

(*d*) The use of loose flux is quite messy in production, and its use hides the joint, making it difficult to direct the wire to the joint especially when contour is irregular.

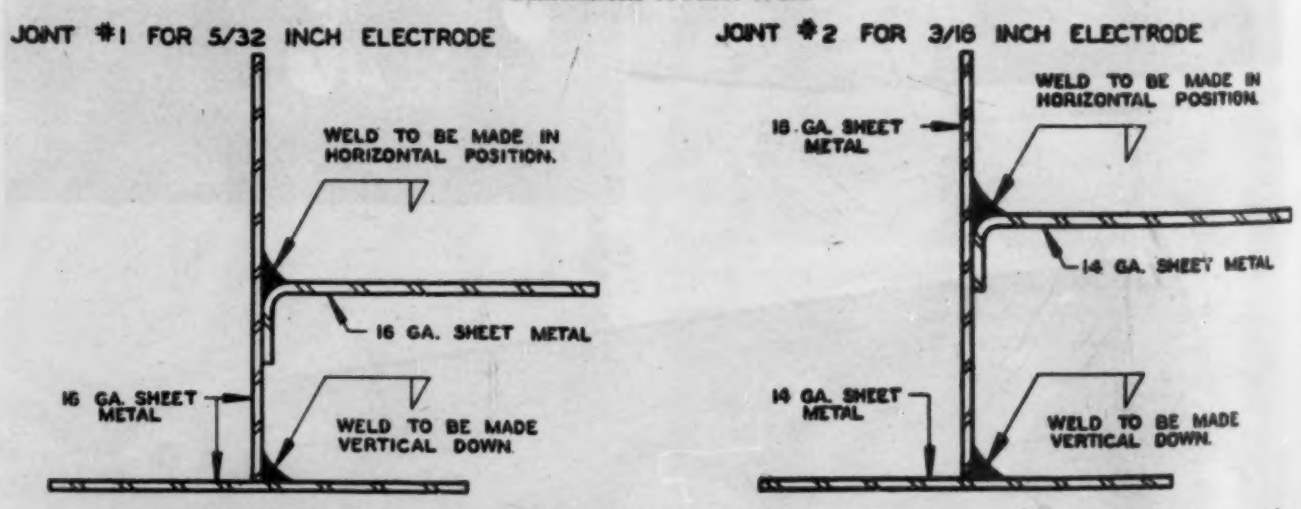
5. Carbon Arc Welding

This process has been used in the automatic form for sheet metal applications in the past. However, it requires additional mechanisms for the string flux and filler metal on the straight butt joints and has the disadvantage of adjusting and compensating these various factors. Even with the string flux the arc shielding is not quite so successful as with the coated electrode or the submerged melt type. Furthermore, there are no particular advantages in speed. Its best use on work of this type is confined to operations which are not too critical on weld quality and on which surface appearance is of secondary importance. Where a flange can be up-turned for melting down by arc to form the joint, the process is quite fast (speeds up to 60 in. per minute), and does not require the addition of any filler metal. Its use on aluminum is quite successful and offers the best speed factor of any method used to date on this material.

6. Automatic Arc Welding

Automatic arc welding has been used in sheet metal production for some time, however, a great deal of the work previously done was with the unshielded arc. Several ingenious methods of shielding the arc for first quality welding have been presented in the last few years which merit consideration. In addition to the string flux already mentioned, one manufacturer offers a tape flux

Dimensions of Fillet Weld


JOINT #1 FOR 5/32 INCH ELECTRODE
WELD TO BE MADE IN HORIZONTAL POSITION.
16 GA. SHEET METAL
16 GA. SHEET METAL
WELD TO BE MADE VERTICAL DOWN
JOINT #2 FOR 3/16 INCH ELECTRODE
WELD TO BE MADE IN HORIZONTAL POSITION.
18 GA. SHEET METAL
14 GA. SHEET METAL
14 GA. SHEET METAL
WELD TO BE MADE VERTICAL DOWN.

All members are 16-gage metal, 3 x 15 in., and are welded with 5/32-in. electrode. The "T" fillet to be vertical down and the flange weld is to be horizontal. Both joints to have not more than 10% drawback or sag on the back of the weld

The vertical member of the "T" is to be 16-gage sheet metal and the other two members to be 14-gage. 3/16-in. electrode is to be used vertical down on the "T" fillet and horizontal on the flange weld. Both joints to have not more than 10% drawback or sag on the back of the weld

Usability Tests—E6013 Electrodes

Fig. 12—Standard Usability Test Adopted for Screening Out Undesirable Electrodes

which is wrapped around the electrode wire after it has received its current. Core wire with extruded coating has been used quite extensively where the current is introduced into the wire by one of several methods of cutting notches through the flux and establishing contact. Another method introduced is the braiding of the core wire so that the flux can be held in between the various strands and filling the gaps but leaving the exterior surface bare, permitting electrical contact. All of these processes offer production speeds considerably higher than the manual arc welding, although their characteristics are quite similar. Some of the advantages are as follows:

(*a*) Higher production speeds.

(*b*) Continuous and readily reproduceable welds, requiring much less operator time.

(*c*) When used with proper coating or flux, welds of first quality can be obtained.

The disadvantages found with this process are:

(*a*) Limitations imposed by quite large and bulky equipment.

(*b*) Surface appearance and bead build-up not as desirable as submerged melt.

(*c*) Flux or oxide removal is necessary before paint.

Table 1 gives a summary of these processes and their comparison.

7. Manual Arc Welding

Although this process has long been associated with mild steel welding, its use heretofore has been quite limited on the lighter gages of sheet steel. Our organization was intimately associated with the problems of this type of welding recently, and have been active in developing some of its recent improvements.

Before summarizing the characteristics to be expected with manual arc welding of sheet metal, our experience with this process might be of interest in order to better bring out the problems connected with this method. As was previously mentioned, the Detroit area was more familiar with fabrication of sheet steel by resistance welding than any other method, and as this condition of indifference toward fusion welding was general, we were no exception. Such was the situation in which we found ourselves when we started the manufacture of our amphibious truck, commonly known as the "DUKW."

Design and construction of the original model of this vehicle was accomplished in only 38 days by our organization, and production schedules were set up to begin only a few weeks later. During the design stages of this vehicle it was quickly apparent that resistance welding could not be used for the major part of the fabrication. Further studies convinced us that of all the processes previously listed, manual arc welding appeared to be the most practical. The size of the unit and the number and complexity of the joints, together with the relatively low quantity called for by the first contract, made automatic equipment impractical.

Since the development time on this vehicle was exceedingly short and as only minor difficulty was experienced by our experimental welding operators in manufacturing the pilot vehicles with 6012 electrode, this type was released for production usage.

The design of the vehicle was controlled by two factors: (1) availability of material, which indicated mild steel; (2) the maximum possible pay load was desired, which indicated that the all steel hull should be made out of stock thickness as thin as possible. This was quite successfully accomplished in that while the bow and exposed floor were a little heavier, the rest of the entire hull was made from 16-gage (0.060-in.) rimmed steel SAE-1010

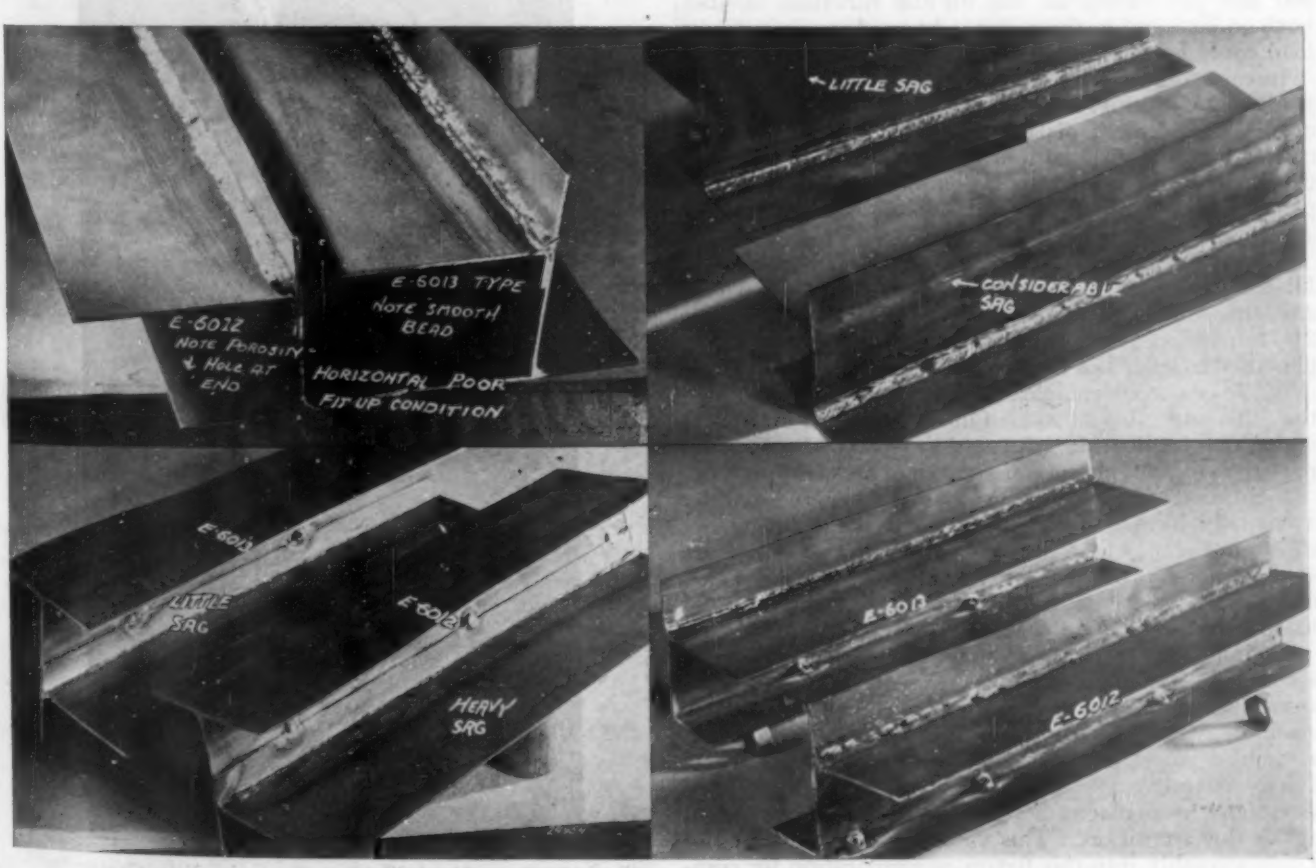


Fig. 13—Examples of Usability Test

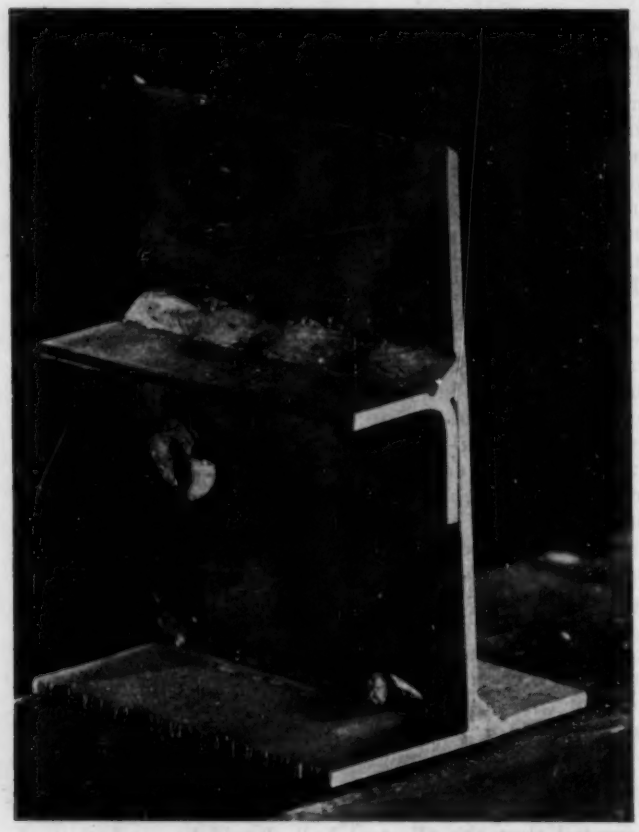


Fig. 14—Close-up of Section Welded with E6012

stock. The decks were even lighter, being made of 18-gage (0.048-in.) material. In spite of the lightness of the structure it was capable of uprooting trees 3 in. in diameter and performing all the normal functions desired, both on land and in the water. As much as six tons pay load could be carried satisfactorily.

In case some of you are not familiar with this vehicle you will note in Fig. 1 that it is not only equipped with a normal complement of land travel accessories, but also carries many additional items found necessary in water travel. In fact the vehicle is complete with bilge pump power winch, forward and reverse speeds on the propeller, and integrated land and sea steering.

It will be noted in Fig. 2, which is an X-ray view of the DUKW, that the location of the power plant, the wheels and the frame are conventional for a six-wheel drive $2^1/_2$-ton truck. Because of the six-wheel drive feature, plus the propeller and its drive, the under part of the hull (Fig. 3) is a very complex structure. It will be noted that this hull is an all-welded integral unit 31 ft. long, 4 ft. high and 9 ft. wide. More than 8000 spot welds are required per hull, plus about $^1/_4$ mile of arc-welding bead.

Lightness of the structure was further realized by using only local reinforcements such as the lifting eye shown in Fig. 4, where the only addition to the structure is $^1/_8$-in. plate joining the two rub rails and a compression member under the deck to prevent collapse of the sides toward the center.

As much of the hull welding as was practical was accomplished in subassemblies. Front and rear floor assemblies were made up and joined into the floor assembly. Side assemblies were made up of three sub-assembled panels already complete with ribs and rails. These assemblies, together with the bow and stern assemblies, were placed in a major fixture, in Fig. 5, in an upside-down position. This view shows the lowering of a side assembly into this fixture in preparation for completing the hull. These assemblies were first spot welded together in order to bring all the joints in tight alignment (Fig. 6). The arc-welding operators started welding on the hull as soon as enough spot welding had been completed to tie that part of the joint (Fig. 7).

All of our operators had to be trained in our own welding school, since at the start of the war only 75 arc-welding operators of all types were employed in the plant. Both men and women operators were trained for this work.

Upon completion of the welding of these joints on the outside of the bottom, the hull was turned upright, as shown in Fig. 8, and several operators started simultaneously to put the sealing beads around the inside of all assembly joints. While many of the outside welds were intermittent, as they were used to join the rub rails to the flanges, the inside sealing beads were continuous welds and had to be water tight. After the welding was completed the hull was lowered into a water tank and tested for leaks. A rather ingenious method of quick testing was developed for these tanks, in that the hull was lowered into the empty tank, anchored, and then the water pumped in. The size of the tank and that of the hull was held as closely the same as possible so that a minimum amount of water would be required. Of course any leaks found were marked and repaired.

Fig. 15—Sheet Metal Welding Electrode, Note Contour of Lower Bead

The hull was then painted and assembled to its chassis and sent on to the final line where certain parts requiring fitting were welded into place (see Fig. 9).

Drive-in tanks were placed at the end of the line so that each DUKW was driven in, again checked for leaks and the engine propeller and winch actually checked before delivery.

At the start of this production program it became quickly apparent that the new welding operators who were just trained and the 6012 type electrode simply would not work well enough together to give us the quality and quantity of production desired. During this period it was found necessary to check each subassembly with compressed air and soap suds for leaks before the major assembly was accomplished. Even then hundreds of leaks appeared in each hull in its first tank test. Furthermore, constant trouble was being experienced with undercut and sag, such as shown in Fig. 10, as well as actually burning through in many places (Fig. 11), and the time required for repairing was excessive. During this time over 50 different electrodes were tested in the welding laboratory without much success, although two more satisfactory electrodes were discovered during this program and substituted on the line. One of the electrode manufacturers consented to come in and work with us on this problem, and at the end of several months developed a sheet metal welding electrode which vastly improved our production conditions. The following data should give you some idea of the extent to which this new electrode improved our welding conditions. Prior to the advent of this electrode our consumption by size was:

20%, $^{3}/_{32}$ in.
40%, $^{1}/_{8}$ in.
40%, $^{5}/_{32}$ in.

with average rate of deposit speeds of 6–8 in. per minute. The new electrode changed this to the extent that our electrode consumption was:

None, $^{3}/_{32}$ in.
20%, $^{1}/_{8}$ in.
40%, $^{5}/_{32}$ in.
40%, $^{3}/_{16}$ in.

with rate of deposit speeds as high as 24 in. per minute. It will be noted that the use of $^{3}/_{16}$-in. electrode was introduced at this time, and the $^{3}/_{32}$-in. electrode size dropped. While not all of our 16-gage joints lend themselves to the use of $^{3}/_{16}$-in. electrode, many of them did, with a corresponding increase in production speed. The new electrode was found to be less critical in arc length, less prone to undercut or sag, more versatile in usable amperage range, better on position work, particularly vertical down.

When this welding program was first set up every effort was made to position as many joints as possible in flat or horizontal. After the advent of the new electrode it was found that vertical down work was even faster and more consistent than the flat or horizontal work, consequently a number of the subassembly fixtures were revised to take advantage of this characteristic.

As our development of a suitable rod for this type of work was rather painful, it was decided to try and establish a test to distinguish the more promising types of electrodes from those definitely not suitable.

After a great deal of work by our Department and later, other Divisions of General Motors, a test was finally evolved which seemed to do a reasonably satisfactory job. This test was purposely made simple (see Fig. 12) so that with a minimum of time and equipment a reasonably good answer could be obtained; differences are shown in Fig. 13. It was not intended, nor was it used to entirely replace production testing which is still felt to be necessary. Our practice in this latter case was to order a small quantity of electrode, enough to load up the entire line for a period of 48 hr., and then make a close check as to the quality of the work and the ease of operator handling.

Study of just what occurred, as in Fig. 14, to make this sheet metal welding electrode better than the others previously tried brought out these characteristics:

1. The transfer of metal from the electrode to the work is of a fine spraying type instead of the heavier droplets usually associated with E6012, and therefore directs itself at a broader area and is not so sensitive to changes in arc direction or length.
2. The bead is somewhat flatter and smoother in general appearance than the E6012 electrode as shown in Fig. 15.
3. The rate of deposit is at least as fast as that of E6012, and seems very versatile in heat range, ranging from 125 to 325 amp., with a $^{3}/_{16}$-in. size electrode as an example. Average amperages used on 16 gage is 160 amp. for $^{3}/_{16}$-in. electrode and 130 amp. for $^{5}/_{32}$-in. size.
4. The flux is easier to clean than with the E6012, partly because of the smoother deposited bead, but still requires considerable time for high quality cleaning.
5. The amount of spatter found is a lot less than with the E6012 electrode.

Some of the postwar applications which have recently been established indicate that the new sheet metal electrode will be as applicable to our peacetime products as it was to the Duck. One example has been the two halves of an automobile hood which had already been set up for gas-welding operation. Demonstration of this new type electrode readily convinced supervision involved that arc welding would be much cheaper and faster (shown in Fig. 16).

This electrode has also been introduced in other plants that heretofore have used arc welding for nothing but light tacking work, and the results already look exceedingly promising.

Even on slightly heavier gages it was recently found that the poor fit-up condition on an automobile frame

Fig. 16—Showing Section of Hood Welded with Sheet Metal Electrode Before and After Metal Finishing

application was overcome much more easily with the sheet metal electrode than with the 6012 electrode. This involved stock thickness of about $^1/_8$ in.

All of the other above-mentioned processes are being carefully reviewed for automotive production right now. In one instance it appears that a two-piece 20-gage assembly is to be welded, with the use of the submerged melt process which tests have shown will give satisfactory results on a 16-gage back-up strip with the root gap varying from 0–$^3/_{32}$ in. This assembly of course will require only disk grinding for metal finishing after welding.

Samples of inert gas welding have looked promising, especially for short corner joints where metal finishing is difficult, as it is believed that the appearance of this bead after welding will be sufficiently good to warrant no further treatment.

These are only some of the specific instances with which I have had contact, and I am sure that many others are in the making right now. Better understanding of the whole process available, together with the new wartime developments should make fusion welding of sheet metal not only more satisfactory, but very much easier than ever dreamed of before.

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Steel House Construction*

By Alfred Fetz†

SINCE the end of the war one subject has been of the greatest interest to the public and government alike—the urgent need for new houses. Designers and industry did respond and new ideas and methods are being developed to meet the rising demand of prospective home owners. Approaching the question of new designs for houses, several ways may be chosen, depending on the ideas considered most important to be carried out. Uppermost in mind seems to be the desire to cut the construction time as much as possible to produce houses at a reasonable price; thus several new methods in building construction have been perfected. From the designers' and manufacturers' point of view all these ideas have their distinctive merits, but what does count in the end is the reaction of the public, of the people who have to buy the finished product. It would be foolish for anybody to manufacture and try to sell anything no matter what its merits are, as long as the public is not ready to accept the product. In an article, "Buyers Reject Economy Ideas," published in the *Detroit Free Press*, Mr. Elvin Stouffer touches upon this question. Apparently Mr. Stouffer has not yet found anything that would be satisfactory to the public in general. The writer is asking: "Why are houses being built with almost the same methods as 50 years ago?" and after making the statement that there are some new methods, is demanding to know why such methods are not being used. Quoted in this article is Mr. Clair Ditchy, president of the Detroit Chapter of the American Institute of Architects as follows: "The American public has a natural resentment against anything connected with house building that is not strictly conventional, and secondary, industry has not seen fit to explore the need of new building tools."

In the second part of this statement Mr. Ditchy is supporting the contention of Mr. Stouffer, and in the first we have the reason given why some new ideas in home design are or will be rejected. Automobile designers know from experience that they cannot make too radical changes in car design as long as they are depending on the public for mass production which alone brings the price of the product within the reach of the average person. These are the facts which have to be carefully considered to make a new design for houses a success. Mass production methods must be used to hold the construction cost low and the design must be so flexible that it satisfies the taste of the individual builder and on to this we should add, the home should be provided with all possible safety devices to give the highest rate of protection in case of war. Undoubtedly there are different ways to solve this problem and one, for which patents are pending, will be discussed in connection with the accompanying sketches. From the discussion it will become evident that by the use of fixtures and the extensive application of resistance welding the experience gained in the mass production of automobiles has been made use of. Take the assembly fixture and the resistance welder away from the automobile assembly line and the line will be dead. Here we have the tools that did make the mass production of cars possible and these tools can be used with the same advantage in the production of houses, with one fundamental difference. In car production the car rolls off the assembly line—in house production the assembly line rolls over the finished product. But one thing is certain, the application of these production methods can do to the house construction what they did to the automobile production

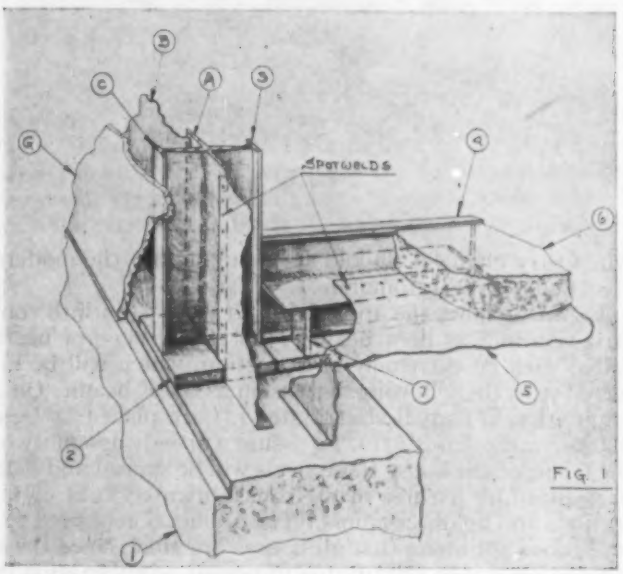
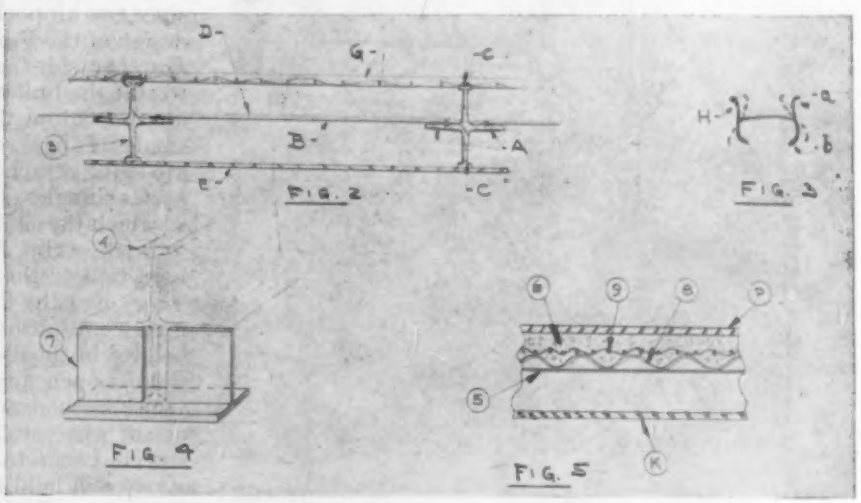


Fig. 1



Figs. 2–5

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† Welding Engineer, Detroit, Mich.

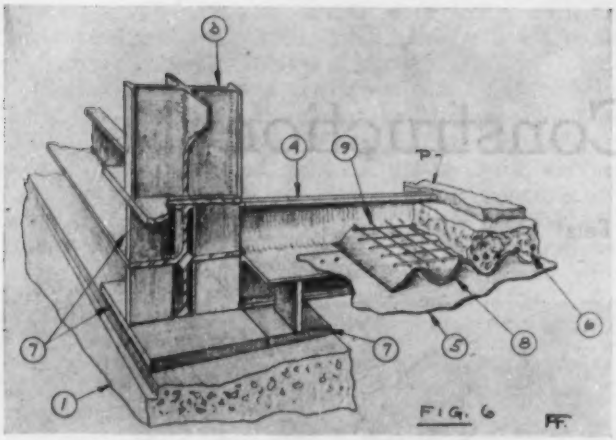


Fig. 6

when they changed the old style buggy into the modern steel body of the automobile.

Figure 1 shows the application as stud (*3*) in wall construction and as floor beam (*4*) of a new type of beam rolled with an extremely light section, which will be referred to in the following discussion as the F-beam. On a foundation (*1*) small steel plates (*2*) are placed as base plates for the studs (*3*). To assure a speedy assembly of the frame of the house these studs will be spaced and held in position by fixtures made from fabricated light metal sections and holding clamps. The application of such fixtures does not mean that all houses are alike, since these fixtures are easily changeable to permit any variation in the design of buildings. The purpose of the fixture is to locate and hold in position standard parts for speedy assembly. For this reason they are light and simple and will be removed as soon as the frame of the building is assembled. On the flanges *A* of the F-beam, light gage sheet metal sheets *B* are placed like wall paper and spot welded to the steel flanges with series spot-welding guns. To illustrate the speed with which this welding will be carried out, let us compare the nailing of wooden frames

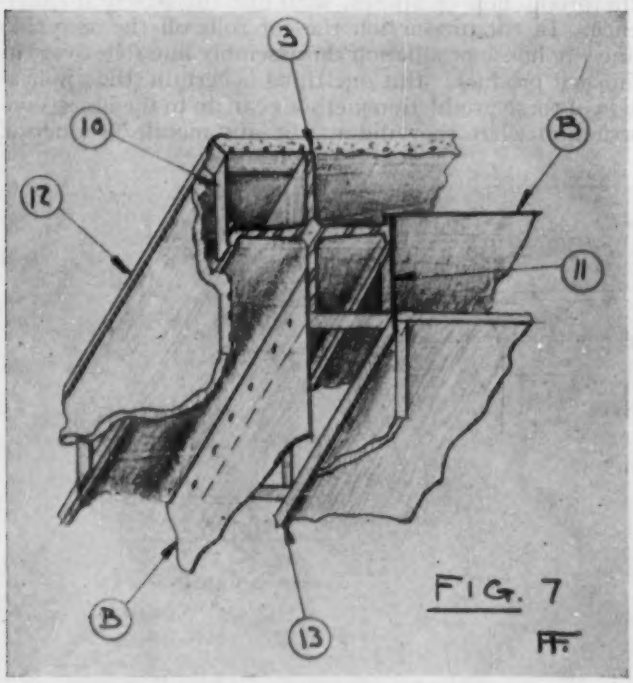


Fig. 7

with the welding. Since we are series welding we are getting two welding spots with every stroke of the welder and the welding time will be about 6 cycles of a second for the two spot welds, which means that at every single hammer blow of a carpenter on the head of the nail, two welds are being performed. While it takes a carpenter to drive one nail into position the welder will have made at least 10 to 16 welding spots. This does not only mean that the welder will cut the time ordinarily spent by a carpenter on a building 10 to 16 times, because we do not need by far as many spot welds on this steel structure as we need nails on a wooden building. As far as the strength of these welds is concerned let us remember that a button will have to be torn out of the steel to separate the two welded parts. The automobile body is held together by spot

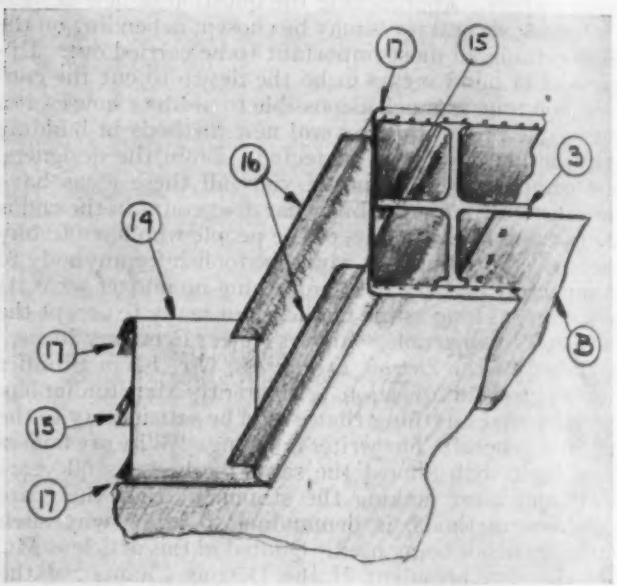


Fig. 8

welds and those are subjected to varying stresses during the use of the car and yet they hold. After spot welding the sheet metal to the F-beam they are sprayed with metal protective paint which serves at the same time as a sealing medium and a glue for the blankets of insulating material *D* which are attached to one or both sides of the partition. The insulation of the house does not depend only on the use of these blankets of insulating material since two air pockets are built into the building due to the design of the F-beam. For the construction of the inside *E* and outside *G* of the wall, different methods can be used to suit the builder and he may stick to the conventional ideas or adopt the modern design. Figure 2 shows two smaller flanges, *C*, to which the inside and outside walls are being attached. In case that the home owner should prefer shingles, steel bars will be spot welded across *C* on to which the shingles will be hung. If preference is given to brick, a clip, *H*, made from spring steel, Fig. 3, will be used to hold the brick wall to the steel frame. This clip snaps over the flanges *C* with the prongs *b* when the fingers *a* are pushed together. The fingers *a* will be embedded in the mortar as illustrated in Fig. 9 and the clip cannot open any more after the mortar has hardened. Other methods of wall construction are obtainable by the use of wire mesh, metal lath or wall boards as base for stucco, concrete or plastic. The wire clip *H* described above will hold the wire mesh or metal lath against the F-beam until they are spot welded to the F-beam for greater strength, although the use of the clip might be

enough since it will be frozen into position as soon as the covering material, which will be applied with sprayguns, has hardened. Should wall- or fiberboards or any other material of this kind be used as base, welding guns of special design will be used to give a strong bond between the boards and the steel and assure again a high speed of production. The construction of the inside walls, *E*, will be similar since we will have the choice of using wire mesh, metal lath, wallboard, plasterboard or similar material as base for plaster or plastic. It is again the customer who will make the choice and the designer and contractor will be able to comply with his wishes. It is not a "Take it or leave it" proposition he will have to expect to pay for a new type of construction that gives the buyer the benefit of saving through the application of mass production methods and mass production tools.

To locate and position the floor beams (*4*) a foot or locator (*7*), Figs. 1, 4 and 6, is used. Sheet metal sheets are spot welded to the flanges *A* of the F-beam and folded over at the foundation to form a pocket which will be filled with concrete when this is poured on to the sheet metal. This concrete in the pocket will be a bond between the studs, the floor beams and the foundation. To strengthen the concrete floor (*6*) corrugated sheet metal (*8*) and wire mesh (*9*) may be placed on the spot-welded

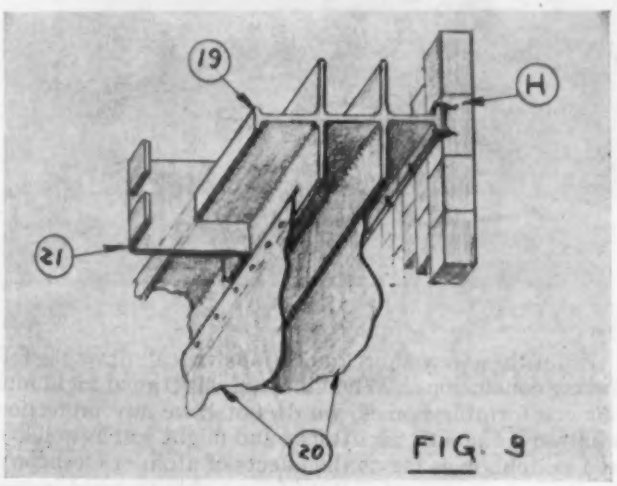


Fig. 9

sheets (*5*) giving a section of floor and roof as shown in Figs. 5, 6 and 10. As a finish for floors plastic *P* will be used on the concrete, giving a flooring like linoleum in various patterns and colors. To increase the insulating qualities of floors and roof, insulating blankets may be attached to the lower side of the sheet metal (*5*). Onto the downward pointing flange *C* of the F-beam the ceiling *K*, Fig. 5, will be fastened, using the same kind of construction and material as for the inside walls. With this design of floor and roof a strong and durable section is attainable with low cost in material and very little labor.

Figure 6 shows a modification in construction, using the standard F-beam which is resting with the locators (*7*) described in Fig. 4 on the foundation of the building. To provide a foot for the studs (*3*) the locators are turned upside down and placed over the F-beam resting on the foundation. The floor beams (*4*) will be used in the same way as described before in the construction of the floor, only in this case the sheet metal spot welded to the flanges *A* will not be bent down to the foundation but rest on these flanges *A* of the F-beams all around.

Figure 7 is a section through the corner of the house illustrating the application of an outer (*12*) and inner (*13*)

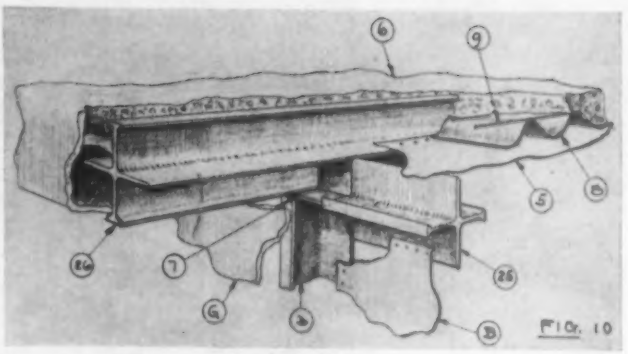


Fig. 10

corner rail. These metal rails are welded to strips *10* and *11*, which in turn will be spot welded to the F-beam to permit a solid corner connection for the inside and outside walls no matter which type of construction is used, with the exception of brick and shingles.

Figure 8 shows the design of a prefabricated steel window frame (*14*). A U-shaped channel (*15*) on the window frame will position the frame (*14*) on the flanges *A* of the standard F-beam all around the window and this channel will be spot welded with welding guns to the F-beam. A tight-fitting solid connection between window frames and the steel structure of the house is assured by this design. To leave the choice of a wooden or steel inner window frame to the builder, the flanges (*16*) are provided for as locators and base. For those who wish to go all the way in this modern design, a new type of window will be available. The outside flanges (*17*) serve the purpose of blending the window frame into the finish of the walls with smooth surfaces on both sides. Should a builder intend to use glass brick in the construction of this house, flanges (*16*) will be omitted and the frame opening in any dimension desired will be filled out with glass bricks.

The discussion so far has shown that no matter which type of wall construction is preferred in connection with the standard F-beam, two insulating air pockets will be created by the sheet metal partition *B* and its insulating blankets *D* fastened onto it. In case that a greater strength of the wall and higher insulating qualities for some reason to be discussed later are called for, a modification in the design of the F-beam is shown in Fig. 9. Here we have one more set of flanges added to the F-beam which will be used now with two sheet metal sheets (*20*) spot welded to these flanges. Otherwise the application of the double F-beam (*19*) in the wall construction is the same. Part (*21*) is a prefabricated bracket which will be welded to the F-beam to support and position the floor beams of the second story of a building. The F-beams will rest on these brackets in the same way as they do on the locators (*7*), Fig. 4.

Fig. 11

Fig. 12

Figure 10 is illustrating the construction of the roof section and upper wall. The standard F-beam is cut to sections (*25*), the length of which is determined by the spacing of the studs, and spot welded to the studs and locators (*7*) for the roof F-beams (*26*) which are placed on the ends of the studs. In any other way the principle of design is the same as discussed before.

The statement has been made that in spite of the fact that mass production methods are being used in the construction of this type of building, each house on a street could be built differently. The accompanying sketches give a few types of steel house constructions possible and the final number of variations in design is only limited by the imagination of the designer. With this type of steel house construction, the architect is very much desirable as the consultant of the home owner who wishes to have a house built that meets his ideas and taste. Steel parts which will be set up as standards, the number of which can and will be kept small, are replacing the wood in this new design. Choosing steel means greater strength and what is equally important, makes the use of resistance welding possible. Architect and builder will have to become accustomed to the use of new materials and high-speed production tools. This is the change that was accepted in the automobile body construction with the greatest success when the all-steel body was created. The builder still has the possibility of designing homes to suit the individual as far as the style of the building and the construction of the walls are concerned. The customer can have anything from the conventional to the ultra-modern. The combination of steel and plastic will assure a high-quality product with very little cost in upkeep and a long life of a fireproof building.

But speed in construction and flexibility in design are not the only advantages of this building method. Several

Fig. 13

months ago pictures were published in *Life* magazine showing the devastation which atom bombs are believed to cause. In the ruins of the completely leveled city of New York only the stone lions in front of the library are left enough intact to serve as a landmark. A picture of this kind of complete destruction is bound to give a feeling of utter helplessness against the power of the atom bomb. After reading a report of Major DeSeversky who was sent to Japan to study the effect of the atom bomb, a conviction that it is possible to give a great deal of protection against this kind of bomb as well as incendiary bombs will replace this feeling of helplessness. In support of this statement the following quotations are taken from the report of Major DeSeversky:

"The destruction was entirely incendiary in character. .... The deaths were due almost entirely to fire and falling structures.... Concrete buildings, even in the very heart of the bomb explosions, remained erect even fragile objects on such buildings are still standing... Had there been modern concrete and steel cities there would not have been such tremendous loss of life."

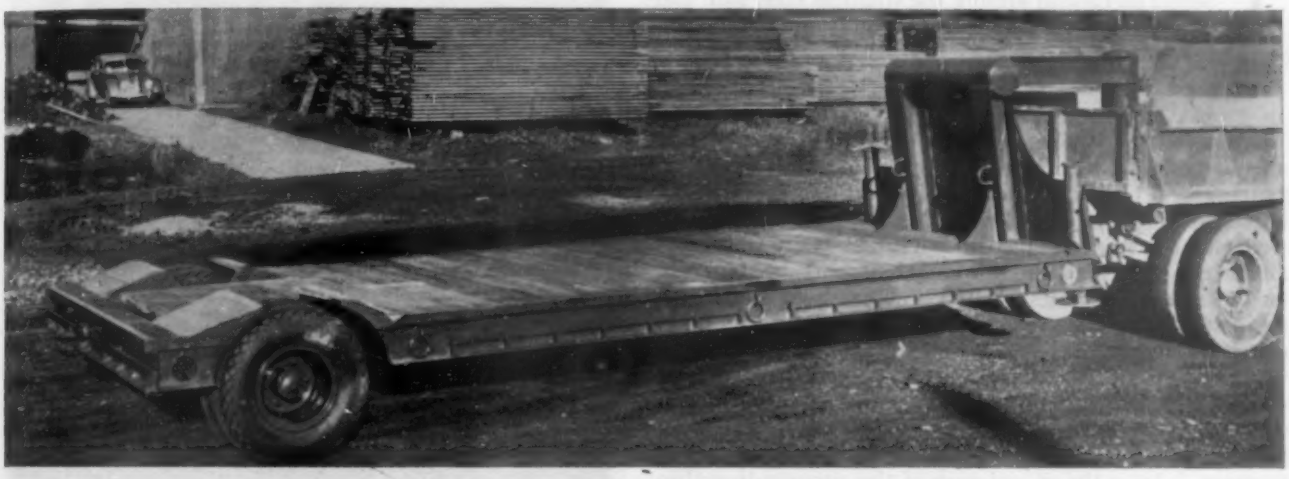
Fig. 14

From these few short quotations we can draw the following conclusions. When most of us retire at night into our comfortable homes, we do not have any protection whatsoever against air attacks and might just as well live in a matchbox as far as the effects of atom or incendiary bombs are concerned. But we are able to build homes which could give a great deal of protection without any or very little increase in the price of the construction, when a house as described above is adopted. To withstand the blast wave of a bomb the house has the sturdiness only steel can give. Suppose intense heat waves are the result of atom bombs. In that case we can use asbestos blankets on the sheet metal partitions *B* of our design. The composition of any concrete used on the outside of buildings may be of the same character as the lining of a furnace. Suppose we do get a momentary but destructive ray effect from atom bombs. Against that we will be able to protect our homes by using lead preparations on the sheet metal partition *B* of the steel house instead of the paint in the wall and roof section. And in case that the atom bomb will have a poison gas effect as prediced lately, the steel house as proposed can be built completely air-tight. To give an amount of protective measure greater yet, the design shown in Figure 9 could be used and made more elaborate to serve this purpose.

The time has come when the pressing need of the day is demanding new materials, new tools and new methods for the modern building industry. There can be no doubt that the steel mills with their modern equipment will be able to produce any steel part called for in the steel house construction on a mass production scale. This means a low price for the most important material. As a mass

production tool the resistance welder has proved its qualification and efficiency. It produces a strong bond between the materials used and the welding time itself is so short that, since it is measured in fractions of a second only, it does not count. Welding machines are in the stage of design for the building industry to assure an easy and efficient handling.

Steel and plastic could very well be the dominating building materials in the future and accepted today in connection with the application of mass production tools may well be able to solve the problem of our housing shortage.



Welded Trailer Featuring Fifth Wheel Dump Truck, Mounting

Welded Trailer Design Features Novel Truck-Mounted Front Suspension

By A. F. Davis*

AN IDEA in welded trailer design that promises to be a boon to contractors, particularly those whose automotive equipment consists only of dump trucks, has been reported by C. W. Lytton, Franklin, Pa., field welding engineer for the Lincoln Electric Co., Cleveland, Ohio.

This heavy-duty trailer has the "fifth wheel" built as an integral part of the design, arranged so that it can be mounted easily in the bed of any standard dump truck body as shown in the photo. This idea not only eliminates the need for a tractor to haul the trailer, but also permits maximum maneuverability of the outfit as compared with trailers such as those of the conventional front wheel type.

The unit, designed and built by Mead Machine and Iron Works, Warren, Pa., has a capacity of 11 tons, is 30 feet in length, and weighs 7745 lb.

The novel mounting arrangement as well as the main frame construction indicates that the company's engineers took full advantage of the freedom of arc welding in designing the structure. Main members consist of 8-x 8-in. H-beams with outside members consisting of 8-in. channels. Skid rails are welded to the top section, sides and rear, with bull rings fused to the frame at convenient positions for securing loads.

The front structure is solidly constructed of H-beams and tubular members with welding of both the intermittent and continuous types used at the joints. Welding was done with general purpose, shielded arc electrodes for mild steel.

The trailer platform has a deck height of 29 in. and is 8 ft. in width. Ground clearance is 20 in., flooring is of air-dried oak, and the unit is equipped with lights to meet all local and Interstate Commerce Commission specifications.

* Vice-President, The Lincoln Electric Co., Cleveland 1, Ohio.

Poke Welding of Stainless Steel Cold Storage Sheathing

By R. K. Waldvogel*

THE object of this investigation was to develop a better method of joining the stainless steel side and ceiling sheathing of cold storage rooms on ocean-going vessels.

Abstract

In accordance with regular erection methods of ocean-going vessels built by Cramp Shipbuilding Co. of Philadelphia during the recent war, the decks and bulkheads enclosing the cold storage compartments were first completed, together with the mild steel supporting structure for the stainless steel sheathing. This sheathing forms the inside surface of the cold storage rooms and its main function is to hold in place a 6-in. thick blanket of insulation between the sheathing and ship structure. These compartments are similar in every respect to an ordinary household refrigerator except that, because of their size, the cold rooms consumed several months for their construction. After the completion of the surrounding ship structure, the sheathing was bolted in place, with the seams being lapped and soldered. In an effort to cut production time and provide a better quality and more durable watertight joint between sheets, laboratory development work on poke welding of stainless steel to mild steel was initiated. After laboratory testing showed the feasibility of this method of erection, a field test of laboratory results was undertaken on one of the vessels under construction. The mild steel supporting structure already erected in conformance to the older method had to be considerably altered to permit poke welding. This added to the cost of erection; however, after making allowances for these changes and also for inexperienced personnel, it was determined that higher quality work could be done in at least the same amount of time necessary for the older method.

Fig. 2—Soldered Beam Caps and Side Sheathing

* Formerly Assistant Welding Engineer, Cramp Shipbuilding Co., Philadelphia, Pa. Presently, Welding Engineer, Pullman-Standard Car Mfg. Co., Chicago, Ill.

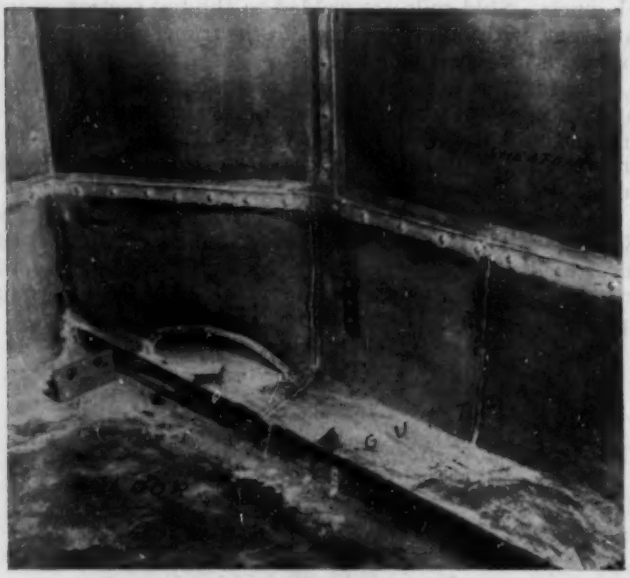


Fig. 1—Bolted and Soldered Sheathing

Present Method of Erecting Side and Ceiling Sheathing

The present method of constructing the side and ceiling sheathing consists of erecting $1^1/_2 \times 1^1/_2 \times {}^3/_{16}$ in. angle supports at a distance of 6 in. from the bulkheads and decks enclosing the cold storage compartments. These angles form a boxlike structure which is arc welded together and supported at the proper distance from the decks and bulkheads by suitable brackets. Strips of $^1/_{16}$-in. thick asbestos are cemented to that surface of the angle which bears against the sheathing. This whole supporting unit is then coated with bakelite varnish to prevent corrosion. The sheathing is temporarily fitted into place and the holes for the $^1/_4$-in. machine screws are drilled and tapped through the sheets and angle supports, the sheets are removed and the holes in the sheathing are counterbored. At the same time, all tubing going through the compartment bulkheads and sheathing is checked for proper alignment and the space between the sheathing and bulkheads and decks is filled with fiberglass insulation, which is held in place by retaining wire.

The compartment is now ready for the final erection of

Fig. 3—Soldering Side Sheets

the sheathing. The floor is fitted first, but since it is 0.078 in. thick, the sheets are butted together with a $^3/_8$-in. root opening and welded with two beads (the asbestos liner is not used here, of course). The gutter, which is the small curved transition piece between the floor and sidewalls, is also 0.078 in. thick and is next arc welded into place as shown in Fig. 1. The side and ceiling sheets shown in Fig. 2 are (with one or two exceptions) 0.031 in. thick. These sheets are all lapped over one another for a distance of 1 in. and there is also a 1-in. lap over the top of the gutter, Fig. 1. The sheets are held in place by $^1/_4$-in. machine screws and the lap seams and screw heads are all soldered (see Fig. 3). The lapped edges of all the sheets are previously pretinned in the shop by dipping the edges into a container of liquid solder for a depth of 1 in.

After the above operations are completed the compartment is tested for leaks, and these are repaired. As a final test the space filled with fiber-glass insulation is put under a 2-oz.-per-sq.-in. air test. This pressure must be held for 10 min., after which the compartment is considered finished and ready for installation of refrigerator coils, fans, lights and shelves.

The disadvantages of the present method as compared to the proposed method are: (1) the low strength and short duration of the soldered joint at the low operating temperatures of the cold room (zero and 15° F.), and (2) the estimated longer time consumed in handling and drilling operations. This will be explained in detail later in the paper.

The Proposed Erection Method and Its Development

The proposed erection method of the side and ceiling sheathing and its development in the laboratory should begin with an explanation of the system used. The kind of resistance welding used for this application is called poke welding and is that type of spot welding where the welding current flow is other than from electrode to electrode and wherein the tip force is applied manually. This is not the most general definition of poke welding, but it applies to our work at Cramp. The equipment used is shown in Fig. 4. As shown in Fig. 5 the poke gun is manually pressed to the stainless steel sheathing and the welding current flows from the poke gun through the thin sheet and the mild steel angle support directly behind the weld to a ground clamp (not shown here) attached to an angle bracket. This completes the welding circuit since both the poke gun and ground clamp are attached to the welding transformer by water-cooled cables.

This process, because of its manual operation, cannot be closely controlled. However, where sections are such as to make it difficult to back up the weld with copper or to use a portable resistance-welding tool, poke welding provides a ready solution to this problem.

After some thought, a flanged butt joint was determined to be suitable for this application since poke welding is most easily done between only two thicknesses of metal. In addition, this type of welding is best accomplished with the gun on the thinner material because more intimate contact can be made at the interfaces. The flanged ends which can be seen in Fig. 6 are approximately $^3/_{16}$ in. high and the bend has an inside radius of $^1/_{16}$ in. The ends of the flanged butt were gas welded together without the use of filler rod; this provided airtightness while the poke welds held the sheets in place. The flanged butt was used, as it was decided that fit-up would be fairly easy and that gas welding could progress fast enough to prevent distortion.

To test the strength of poke welds made with various machine settings, a standard tensile specimen was devised consisting of one piece of stainless steel and one piece of $^3/_{16}$-in. mild steel, or consisting of 2 pieces of stainless steel. Each of these pieces measured 1 x 5 in. and they were lapped over each other for a distance of 1 in. and poke welded together. Figure 7 shows some tensile test specimens undergoing a corrosion test, which will be described later. Figure 8 shows the spot-weld tensile testing machine, which was used to determine the

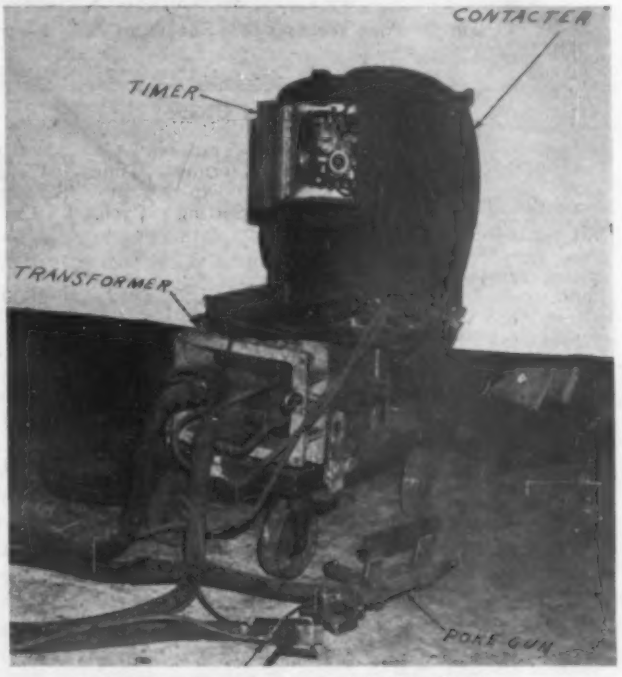


Fig. 4—Progressive Poke Welding Machine

strengths of the welded specimens. Several hundred tests were made using different materials and machine settings to find the best combination of spot appearance and weld strength. Table 1 shows the results of this testing. The design weld strength is at least 100 lb. below the lowest values ever obtained from testing. The transformer tap settings are listed instead of welding current in amperes because we did not have the electrical equipment to measure these values. Two dome-shaped tips were tried in testing, one with a tip radius of 1 1/2 in., the other with a 2 1/2-in. radius. The 1 1/2-in. tip radius gave 150 lb. greater average weld strength than the 2 1/2-in. radius. Two tip diameters were also tried, 3/8 in. and 5/8 in., but this difference by itself did not affect the weld strength. A 3/8-in. tip diameter was chosen because of convenience. A distance of 6 ft. was maintained between the ground clamp and the welding operation. The 0.078-in. 18–8 material is not listed in Table 1 as it could not be effectively

Fig. 5—Poke Welding Side Sheathing

Table 1—Welding Chart

Pile-Up	Tip Diameter, In.	Tip Radius, In.	Transformer Tap Setting	Time in Cycles	Design Weld Strength, Lb.
0.031-in. 18–8 to 3/16 in. 18–8 metal-sprayed mild steel	3/8	1 1/2	2L	12	1000
0.050-in. 18–8 to 3/16-in. 18–8 metal-sprayed mild steel	3/8	1 1/2	1H	12	1000
0.031-in. 18–8 to 0.125-in. 18–8	3/8	1 1/2	2L	10	1000
0.050-in. 18–8 to 0.125-in. 18–8	3/8	1 1/2	2L	16	1000
0.031-in. 18–8 to 3/16-in. wire-brushed mild steel	3/8	1 1/2	2L	12	1000
0.050-in. 18–8 to 3/16-in. wire-brushed mild steel	3/8	1 1/2	2L	16	1000

Ground distance = 6 ft.

Fig. 6—Poke- and Arc-Welded Sheathing

poke welded with our equipment; therefore, it was arc welded. To obtain the highest weld strengths possible, the mild steel had to be cleaned by either wire brushing or grinding, whichever method was more convenient.

It was interesting to note that after several welds were made, a small round projection, a few thousandths of an inch high and 1/8 in. in diameter began to form in the center of the tip on the welding surface. Its presence did not affect welding in any way although its formation was a mystery. The poke weld was cross-sectioned and etched, showing 80% of the weld slug in the stainless steel while 20% was in the mild steel. This, of course, was not good welding, but was an inherent result of the poke-welding process and was entirely satisfactory for this application.

You will note in Table 1 that the first two pile-ups listed in column 1 mention 0.031- and 0.050-in. stainless steel to 3/16-in. thick metal-sprayed mild steel. The leg of the mild steel supporting angle bearing against the sheath-

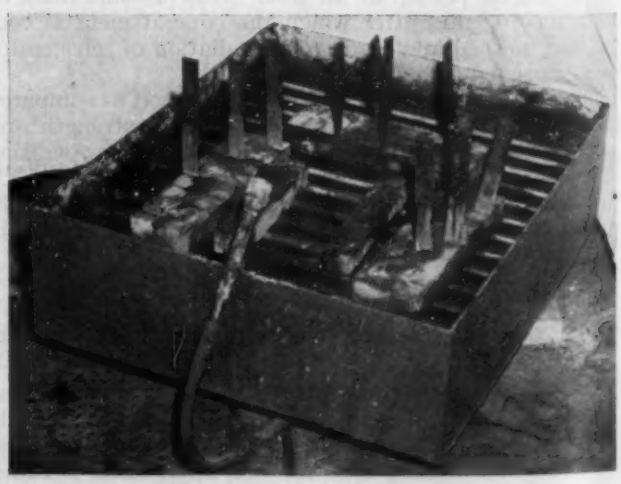


Fig. 7—Corrosive Spray Box

ing was coated with a 0.020-in. thick layer of stainless steel metal spray to prevent rusting around the weld with a consequent reduction in weld strength. The remaining surfaces of the angle were coated with bakelite varnish which prevented rusting and, when dry, was an electrical insulator. It was the author's opinion that metal spraying was unnecessary, in other words, that corrosion would not reduce weld strength. However, it was done at the contractor's request, since there was insufficient time to run a corrosion test to determine whether metal spraying would be necessary for this application. A test was started for future information to find out if a corrosive atmosphere lowered the weld strength. Figure 7 shows the corrosion box (top removed) which was made from this test. A series of 24 specimens were poke welded for this test, all 0.031-in. stainless steel to $^3/_{16}$-in. mild steel. Twelve specimens had no protective coating on the mild steel and 12 had the mild steel coated with stainless steel metal spray 0.020 in. thick. Four control tensile tests from this group were pulled immediately to give us a strength level on which to base the effects of corrosion; two control tests had bare mild steel while two tests had metal-sprayed mild steel. The remaining specimens were placed in a dilute salt-water corrosive spray for a 500-hr. period, after which 10 specimens were removed and pulled. Five of these were of the bare mild steel type shown on the left in Fig. 9 and 5 were metal sprayed, shown on the right. The strips of 0.031-in. stainless steel are shown lying on top of the mild steel after pulling. The weld strengths are tabulated in Table 2, and show a decrease from the control strength of 6 to 10%. This is not considered significant as the sheathing does not undergo any loads in service, its purpose being to protect and hold the insulation in place. It was decided that in the ordinary lifetime of an ocean-going vessel the rusting of the mild steel angle supporting members would result in a negligible decrease in weld strength.

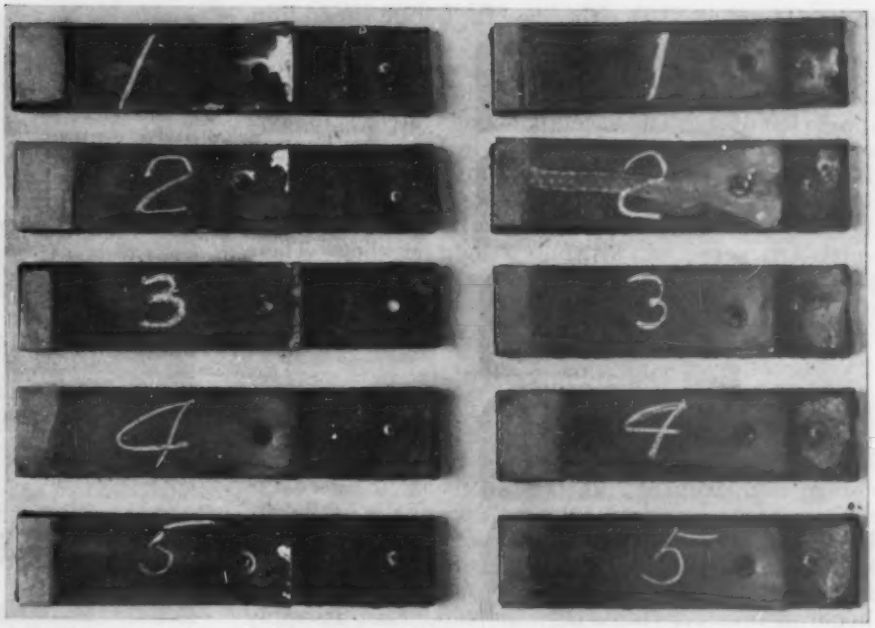


Fig. 9—Corrosion Test Specimens

Table 2—Poke Weld Corrosion Test

	Tensile Strength	
	0.031-In. 18-8 to $^3/_{16}$-In. bare Mild Steel	0.031-In. 18-8 to $^3/_{16}$-In. Stainless Metal-Sprayed Mild Steel
Control Specimen No. 1	1280	1110
Control Specimen No. 2	1160	1250
Test Specimen After 500 Hr. in Dilute Salt-Water Spray		
1	1100	1140
2	1175	1135
3	1000	1100
4	1010	1040
5	1240	1140

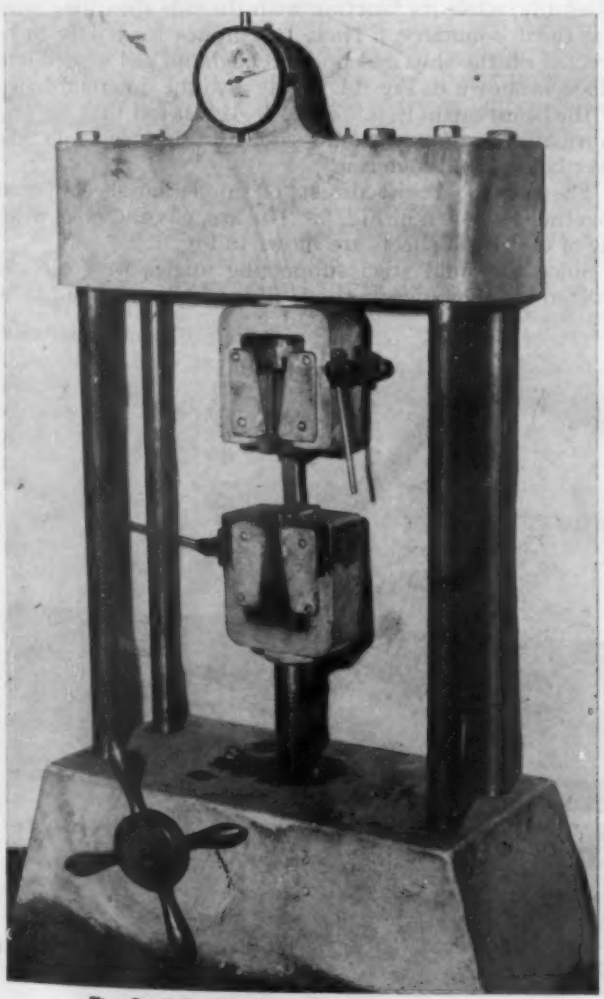


Fig. 8—Poke-Weld Tensile Testing Machine

To calculate the spot spacing necessary to provide the same joint strength as a bolted lap, bolted tensile tests were made and pulled until failure as shown in Fig. 10. Note how the ductile stainless steel elongates before breaking. The bolt strength and spot weld center-line distance calculations are given in Table 3. The mode of failure depended on whether the hole in the stainless steel strip cut into the root of the thread under the head of the machine screw (in this case the head sheared off) or whether the stainless steel was pulling against the smooth shank of the screw under the head in which case the stain-

less steel fractured. In either case the failure varied from 1600 to 3200 lb.

As a final test we made an all arc-welded steel box measuring approximately 27 x 15 x 2 in. with one 27- x 15-in. side left open. Two sheets of stainless steel were silver soldered to the open side as shown in Fig. 11. The two sheets were poke welded to a $^3/_{16}$-in. flat bar down the center of the opening and then gas welded together. The sheets were put under a pressure of 6 psi., (service pressure equals 2 oz. per sq. in.) with only a slight buckling. There was no failure. These results show that the joint has adequate strength for its intended service.

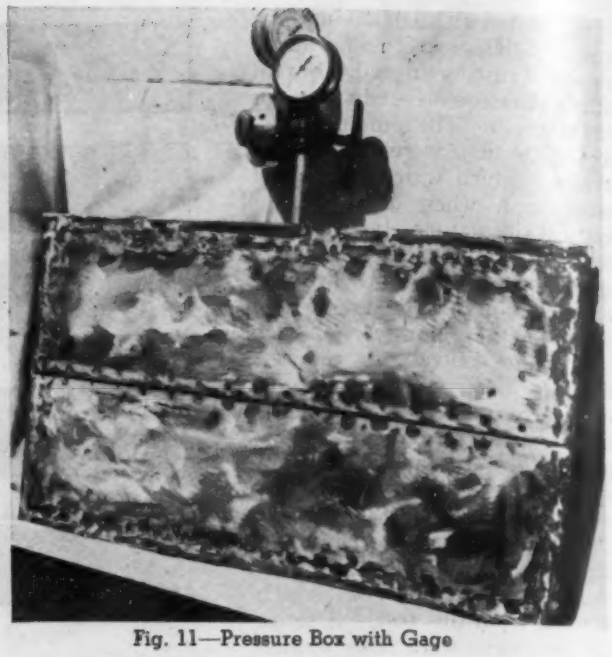


Fig. 11—Pressure Box with Gage

Field Test of Proposed Method

With the positive test results at hand, it was decided to make a shipboard test on a small butter and egg cold storage compartment. It was necessary to erect the mild steel supporting structure with the angles in slightly different locations so that poke welding would not have to be done in corners or other inaccessible locations. The poke-welded ceiling sheathing was subassembled in the shop from templates lifted from the ship. Each assembly covers a ceiling area of approximately 2 x 4 ft. and includes one-half of the beam cap and the top 13 in. of the sidewall. Each assembly was silver soldered into one piece before ship erection. Figures 12 and 13 show these details. You will note how the seam starting at the top center in Fig. 12 bisects the beam cap. This seam and the similar butt to its left gives two boundaries of one ceiling assembly, while its junction with the side sheathing gives the third boundary. These assemblies have only to be erected on the ship and poke welded and gas welded into place as shown in Fig. 14. Note also the different design of the beam cap in Figs. 2 and 12. It was felt that the prefabricated beam cap would save considerable fit-up time over bolting and soldering.

The side sheathing consists of simple flat sheets joined together as shown in Fig. 5. The arc, gas and poke welding of the gutter sheets are shown in Fig. 6.

Since the mild steel supporting angles were already erected for the older method, additional angles had to be

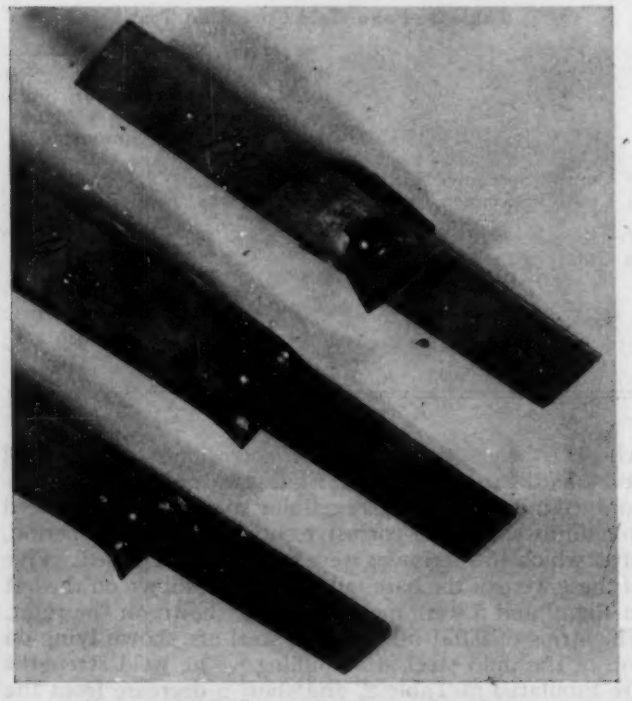


Fig. 10—Bolted Tensile Specimens After Failure

Table 3—Strength Comparison of a Bolted Lap Joint with a Welded Lap Joint

Pile-Up	Lowest Joint Strength: Weld	Lowest Joint Strength: Screw	Spot-Weld Spacing, In.
0.031-in. 18–8 to $^3/_{16}$-in. mild steel	1000	1600	$1^1/_2$
0.050-in. 18–8 to $^3/_{16}$-in. mild steel	1000	1600	$1^1/_2$

Calculations: $\frac{\text{Strength of screw joint}}{\text{3-In. } \text{℄ distance}} = \frac{\text{Strength of spot-weld joint}}{\text{"X" } \text{℄ distance}}$

$\frac{1600}{3} = \frac{1000}{X}$; $X = 1.875$ In. Assume $1^1/_2$ In.

A $1^1/_2$-in. spot-weld spacing gives a strength equal to that of a bolted lap.

NOTE: Centerline distance for machine screws is 3 in.

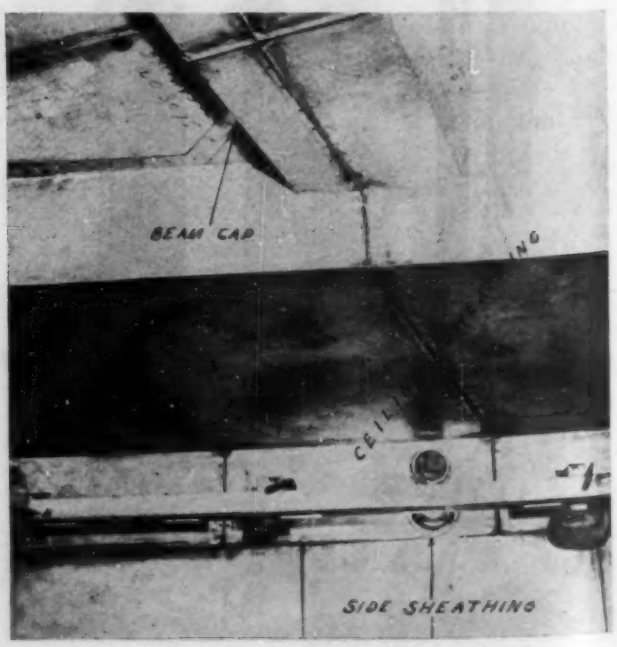


Fig. 12—Sheathing Details

Fig. 13—Sheathing Details

installed and the whole supporting unit sand blasted and metal sprayed, as discussed above.

The compartment was now ready for erection of the sheathing. As stated above, templates for all the sheathing assemblies were lifted from the ship, and all forming, bending and silver soldering of the sheets were done in the shop. The ceiling assemblies were erected and fitted into place first. This operation took longer than the estimated time due mainly to the large number of bends and corners. The importance of careful work was not sufficiently impressed on the shop personnel, and this fact caused some sheets to fit rather poorly. However, the poke welding and gas welding of the sheets proceeded without difficulty. Copper plates were held on each side of all seams during gas welding to prevent warping of the sheets.

The gutter sheets were next erected and fitted. Since these sheets are 0.078 in. thick they were arc welded in place (see Fig. 6). The side sheets were erected and welded last. Since these sheets were both easy to fit in place and weld, this operation was finished rather quickly.

Pipe sleeves and breather openings were next silver soldered in place, as shown in Fig. 15. Warpage was kept to a minimum by using damp cloths around the heated area. Last to be welded were the side and ceiling sheets to the $^1/_8$-in. thick stainless steel door frame. The original bolted and soldered frame is shown in Fig. 16. The welded door frame is shown in Figs. 13 and 15. You will note that the poke welds and arc welding were simply substituted for bolts and soldering, respectively. The arc welding was done by using short increments and a wandering sequence. There was no warpage.

The sheathing was now completed and was tested for leaks by putting a 2-oz.-per-sq.-in. air pressure behind the sheathing and applying a soap solution over all the seams. There were relatively a large number of leaks, mostly

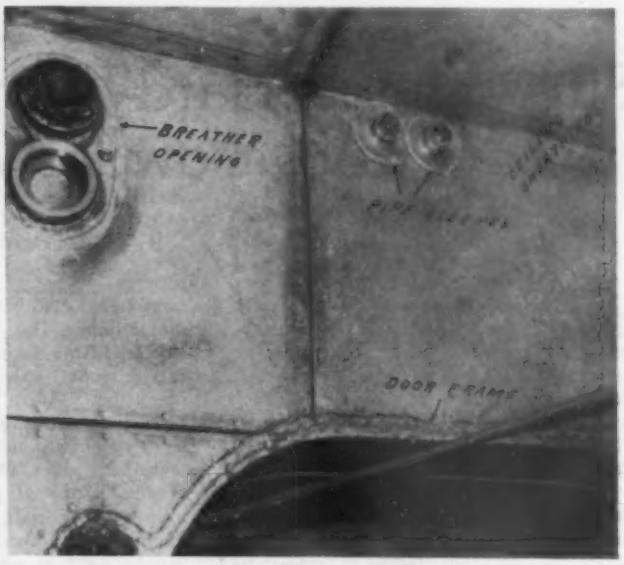


Fig. 15—Pipe Sleeves and Breather

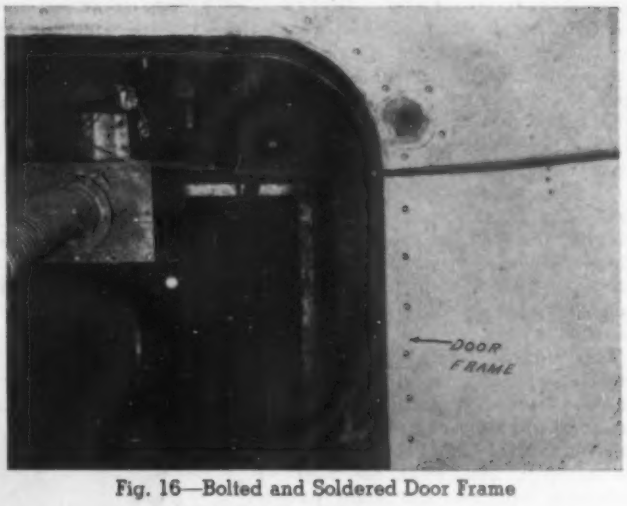


Fig. 16—Bolted and Soldered Door Frame

where the flanged butts intersected each other at right angles, but these were easily repaired. The amount of leaks in regular production work could be reduced to an insignificant number, as the experience of the welders increases.

Fig. 14—Poke Welding Ceiling Sheets

Discussion of Field Test Results

The quality of work was high considering the relatively unfamiliar type of work involved. The sheet metal workers on the ship were very careful in fitting the sheets. This was important since careful fit-up was necessary for good welding and neat appearance of the finished job. The poke welder, the gas welder and the arc welder were efficient and they did good work in their respective fields.

Erection time was the same as for the bolting and soldering method. However, since drilling, tapping and counterboring of holes were eliminated, future work along with the added experience of the shipyard personnel would result in 10% reduction in construction time with approximately the same cost involved. The equal cost was a result of the higher wages paid the welding operators as compared to the sheet metal workers. This type of joint will not be more leakproof than bolting and soldering but welding is more durable and longer lasting.

The above results recommend themselves to further application since welding gives a more durable joint at approximately the same cost with a 10% reduction in construction time.

Streamlined Hard-Facing by the "Spray-Weld" and "Powder-Weld" Processes

By C. J. Long* and T. E. Rich*

BOTH these processes will probably be of primary interest to industry, since they combine—for the first time, we believe—the principles and advantages of metalizing and hard-facing welding practice.

In the initial stages of both processes, metalizing practice is employed to obtain a smooth, uniform deposit of Colmonoy No. 6 hard-facing alloy. When this phase of the operation has been completed, this sprayed overlay is bonded to the base metal by either an oxyacetylene torch, induction equipment or a controlled atmosphere furnace.

Regardless of which of the three heating mediums is used, the final result is a fusion or molecular bond between the sprayed overlay and the base metal—identical to that obtained when the same alloy in welding rod form is applied by oxyacetylene welding.

To better understand the mechanics of the fusing operation it is necessary to describe the peculiar properties of the alloy which make this possible—freedom from oxidation at high temperatures, long plastic range and excellent wetting characteristics.

This "Plastic Range" starts at about 1850° F. when the metal leaves the solid state, and becomes plastic or mushy. It continues in this plastic or mushy condition to about 2050° F. Thus, between the temperatures 1850 to 2050° F., Colmonoy will wet and bond to steel, stainless steels, cast and meehanite irons, and copper and some of its alloys without flowing or losing its shape.

Both processes consist of three steps.

The first step in either process is the preparation of the base metal for spraying. This operation follows, in general, standard metalizing practice. The hardness of the surface to be sprayed is determined, and if softer than 28 Rockwell C it is grit-blasted. If harder, a thin film of nickel is applied by either of two satisfactory commercial processes. It might seem at first glance that these precautions are superfluous as the overlay is ultimately bonded to the base metal. It is important, however, that a good mechanical bond be effected between overlay and base metal during the spraying, to avoid the overlay lifting during the fusing operation.

The second step is the actual spraying operation. With the "Powder-Weld" process the alloy is sprayed in powdered form through a newly developed powder metalizing unit. With the "Spray-Weld" process a special plastic bonded rod is used. These rods are about $\frac{1}{8}$ in. in diameter and about 36 in. long. They can be used in any wire metalizing gun equipped to handle wire of this diameter. It may be of interest to note that these rods are a composition of the alloy in powdered form held together with a plastic binder. As the rod is fed through the metalizing gun, the plastic volatilizes, leaving the particles of alloy to continue on to the target.

The third step of either process is the fusing of the overlay to the base metal. As explained earlier this may be accomplished with either an oxyacetylene torch, induction equipment or a controlled atmosphere furnace. With any of them it is simply a matter of bringing the overlay up to the "Plastic Range" at which time a bond is effected. It may be of general interest to know that most jobs can be done very satisfactorily with an oxyacetylene torch. If the article is large and flat, or if a great many pieces are to be done, it is best to use a furnace if available. On cylindrical parts induction heating can often be used to advantage if available.

On fusing the overlay shrinks approximately 20%, the reason being that the sprayed particles fuse together and bond to themselves and the base metal to form the dense hard overlay characteristic of Colmonoy No. 6.

It will be readily appreciated that there are great advantages—and some limitations—to both processes.

Advantages.—1. There is no porosity in the overlay from either process.

2. Any contour may be followed, and any job can be done where the surface can be sprayed, and any of the heating mediums mentioned applied.

3. The overlay from either process is smooth and uniform, requiring a minimum of grinding; the maximum to be removed

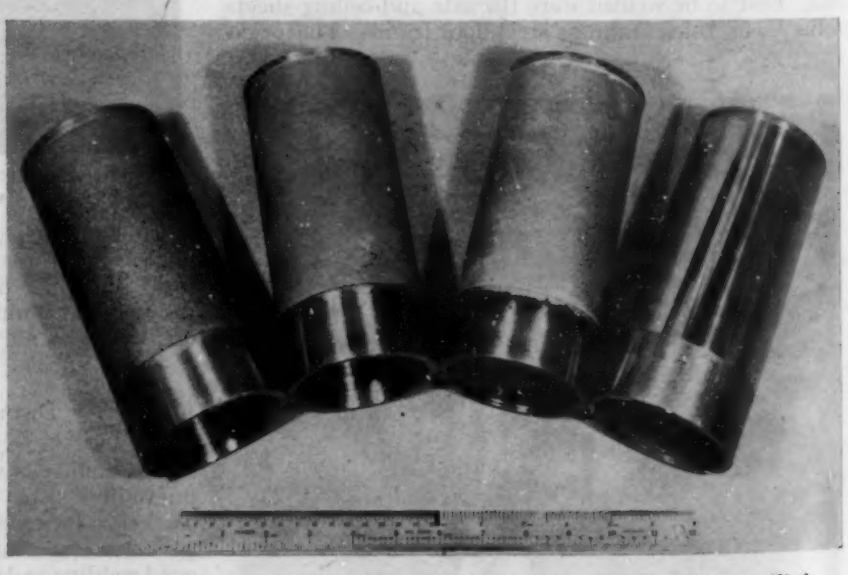


Fig. 1—Sleeves Illustrate (1) the Undercut and Blasted Surface Preparation, (2) the Deposited Overlay, (3) the Deposited Colmonoy After Fusing in Controlled Atmosphere Furnace and (4) the Finish Ground Surface

* Wall Colmonoy Corp., Detroit, Mich.

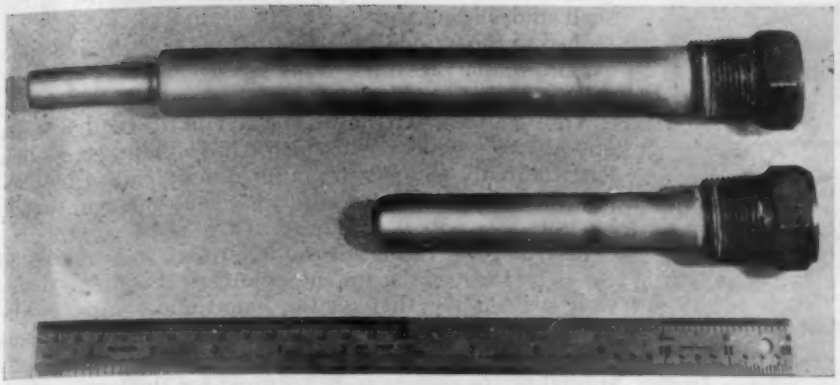


Fig. 2—Two Thermocouples, Requiring No Finishing at All

on any job done to date being 0.012 in. per side for concentricity and finish.

4. It is faster and more economical than any other method of hard-facing, in practically all cases.

Limitations.—1. The minimum amount of overlay it is practical to apply per side is 0.010 in. (provided this surface does not have to be finish ground). The maximum amount is 0.050 in. per side with the "Powder-Weld" process, and 0.060 in. with the "Spray-Weld" process.

2. On small pieces the heat required to fuse the overlay might destroy certain physical properties of the base metal.

Uses of the Processes

Since these processes are limited to the use of one alloy, the finished product has all the advantages of Colmonoy's great resistance to both wear and corrosion, its high red-hardness, its nonsparking and nonmagnetic properties.

Because of these properties and the flexibility of the application, it may be used on any job where (*a*) the properties of the alloy are desirable, and (*b*) where the limitations of the processes are not applicable.

Large Gas Holders at Long Beach Feature All-Welded Construction

By H. O. Hill*

A BATTERY of four horizontal cylindrical pressure gas holders, among the largest structures of their type ever built and the first of this size made of all-welded construction, has recently been installed for the Gas Department of the City of Long Beach, Calif.

The holders, each having a volume of 175,000 cu. ft., were designed and constructed by the Fabricated Steel Construction Division of Bethlehem Steel Co., and erected under their supervision. They are capable of holding gas compressed to 55 psi. gage pressure, which will be released into the gas mains until the pressure has dropped to 13 psi. A storage of 500,000 cu. ft. of usable gas is thus provided by each container.

* Assistant Chief Engineer, Fabricated Steel Construction Division, Bethlehem Steel Co.

Fig. 1—Column, Ring Girder and Linkage Attachment, Long Beach Gas Holders

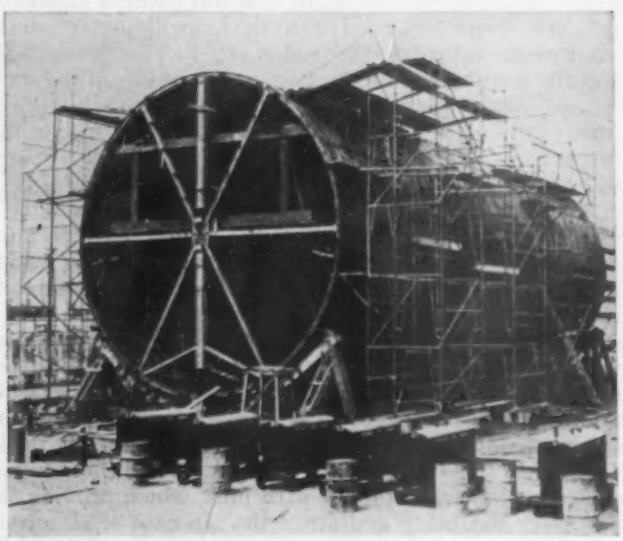


Fig. 2—Construction of Shell Showing Construction of Spiders

Each holder consists of a cylindrical barrel 34 ft. in diameter and 171 ft. 8 in. long, with two hemispherical heads, making the total length 205 ft. 8 in. Steel plates 0.81 in. thick are used in the cylindrical section and 0.41-in. plates in the heads.

Each cylinder is held to shape by means of two external ring girders, spaced at 110 ft., and each girder is attached to two columns which provide the support for the holder. The structural supporting members were designed according to the specifications of American Institute of Steel Construction and to the Long Beach building code.

The entire design conforms to the requirements of the

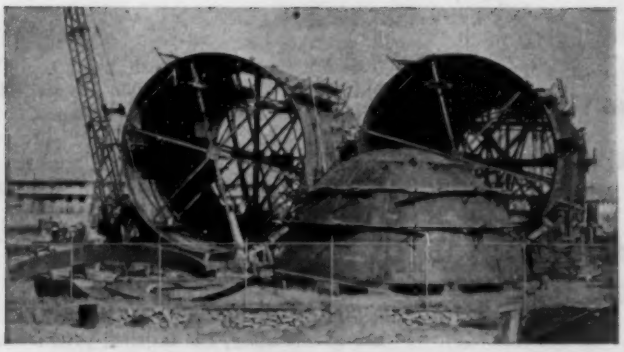


Fig. 3—Assembly of Dome and Shell

Pressure Vessel Code of the American Petroleum Institute and the American Society of Mechanical Engineers. High-tensile carbon-silicon steel designed for boilers and other pressure vessels, conforming to American Society for Testing Materials specification A-212, Grade B, Firebox quality, was used in shell and head plating. This steel has a minimum ultimate tensile strength of 70,000 psi. The allowable working unit stress permitted by the above code is 17,500 psi., and the allowable welded-joint efficiency 80%, which reduces the working unit stress to 14,000 psi. This value is only one-fifth of the minimum strength of the plate material, a good margin of safety in design.

Each holder is protected against overloading by two 4-in. safety valves set to open when the pressure exceeds 55 psi.

The structures were designed for a seasonal temperature variation of 100° F., which will cause a change in length of about $1^1/_2$ in. Due to the large diameter a maximum temperature differential of 50° F. was assumed for top and bottom and for the two opposite sides of the shell, a condition which will deflect the holders from a straight line. The holders were also designed to resist a seismic impact of 20% of gravity applied horizontally in any direction, as well as vertically.

The design of the supporting ring girders presented a complex mathematical problem. These girders must support the holders under all conditions of loading taking into consideration temperature differentials, wind and seismic loading, and the weight of the structure.

In the design of the columns and the connections provisions had to be made for changes in length with the temperature, warping of the cylinders due to temperature differentials between the two opposite sides, wind and seismic loading, and the weight of the structure itself. The connections between the ring girders and the columns consist of linkage attached with pins, which provide the necessary flexibility and strength. In case of abnormal end movement due to seismic impact a special safety provision in the connection allows a pedestal on the ring girder to engage the top of the column, thus supporting the holder directly on the columns.

The bottom of the shell adjacent to one ring girder is attached to a double support in the foundation known as the fixed-shear button. Each part of the double attachment consists of a pipe cylinder connected to the shell and sliding vertically inside another cylinder attached to the foundation, thus giving the shell freedom to expand under pressure. This arrangement is capable of resisting wind pressure, temperature and seismic loading.

Another shear button was placed on the bottom of the opposite ring girder. This button has a sliding connection longitudinally which will permit motion caused by temperature changes, but it will resist side wind and seismic loading.

Five rings of 12 plates, each plate 107 in. wide and 30 to 40 ft. long, make up the cylinder. Each two plates were welded together on the longitudinal seam by the automatic submerged-arc method. The welding was done in the shop and the assemblies were so large that special police escorts were required for the trucks which hauled them to the site. The remaining six longitudinal seams in each ring were welded manually at the site.

Each hemispherical head was made up of 12 segmental plates and two cap plates, all die-pressed to shape in the shop. They were completely assembled by welding at the site before they were attached to the cylindrical sections. The welded joints, both in the main sections and in the hemispherical ends, were double-grooved, double-welded butt. All manual welds in the shell plating were peened after each weld pass except the first and cover passes. This peening was done when the weld metal was warm to the hand.

The procedure used for welding each type of joint was qualified to prove its suitability by means of the methods established for this purpose by the AMERICAN WELDING SOCIETY, and the ability of all welding operators was tested according to the SOCIETY's procedure.

All inside and outside welded seams in shell and head plating were examined by magnetic powder testing. These tests are not required in the code under which the vessels were constructed, but were adopted by the contractor as an extra precaution to prove the soundness of the welded joints. Any defects disclosed were chiseled out to sound metal, rewelded, and then tested again.

After the completion of each holder all welded seams were further tested against leakage by brushing soapsuds over the seams and applying air pressure from within. Possible leaks were thus disclosed by air bubbles. Lime wash was then applied to certain seams and more highly stressed points on the shell and ring girders. After the wash had dried to a brittle coating the internal pressure was raised to 50.5 psi. and the coating was inspected for flaking which might indicate overstressing of the materials.

After satisfactory completion of the tests, the holders were purged with carbon dioxide gas to remove all air, and then the carbon dioxide was flushed out by illuminating gas. This method of purging follows the procedure established by the American Gas Association and precludes any danger of having an explosive mixture of air and illuminating gas in the holder at any time. Upon completion of these operations the holders were ready for service.

Fig. 4—Completed Gas Holders

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THE AMERICAN WELDING SOCIETY

ACTIVITIES - RELATED EVENTS

STANDARD CODE FOR ARC AND GAS WELDING IN BUILDING CONSTRUCTION

The AMERICAN WELDING SOCIETY Committee on Building Codes has just completed a 1946 edition of the *Standard Code for Arc and Gas Welding in Building Construction* to replace the 1941 (tentative) edition. This Code in its earlier editions has been widely adopted by municipalities for the administration of welded construction under their jurisdiction. The new edition embodies revisions based on experience in the recent applications of welding to structure fabrication and on further research investigation.

A section on design now provides for increased allowable weld unit stresses equal to those allowed for the steel being welded. Other sections on filler metal, workmanship, inspection and qualification of welding operators and procedures have also been revised.

Copies may be obtained from the AMERICAN WELDING SOCIETY, 33 W. 39th St., New York 18, N. Y., at 50¢ per copy.

NATIONAL METAL CONGRESS AND EXPOSITION

As of July 1st, 86% of the exhibit space for the 28th annual National Metal Congress and Exposition has been sold. Specific areas have been assigned to 275 exhibitors for the five-day event which will be held in Atlantic City's Municipal Auditorium beginning November 18th.

W. H. Eisenman, managing director of the NMCE, explained that floor plans had previously been sent only to former exhibitors in the show. Because of current interest among nonexhibitors (in preceding NMCE shows) floor plans are now being sent to them. With space reservations moving faster than for any preceding show, it is anticipated that the entire available space will be quickly reserved.

Advance programs of the participating societies reveal that unusual interest is being displayed by authors of technical papers. Already, the program committee of the American Society for Metals reports that more than twice the normal number of papers have been submitted by members for consideration and possible presentation before the ASM sessions during the NMCE. The AMERICAN WELDING SOCIETY, the Iron and Steel Division and the Institute of Metals Division of the A.I.M.M.E., and the American Industrial Radium and X-Ray Society, also participating in the Metal Show, report unusual activity in the same field in preparation for the Atlantic City meetings.

NMCE exhibit space will be utilized to show many advancements in production and manufacturing techiques evolved during the past five years. Due to wartime security regulations, most new methods necessarily remained classified. Now, however, with the lifting of Army and Navy restraints, many of the new methods will be revealed for the first time.

BOARD OF DIRECTORS MEETING

A meeting of the Board of Directors of the AMERICAN WELDING SOCIETY was held on Thursday, June 20, 1946, in the Board Room, A.S.C.E., Engineering Societies Bldg., New York City.

The meeting was called to order by President Hess at 9:45 A.M., with the following present.

Members: C. A. Adams, F. W. Davis, J. H. Deppeler, O. B. J. Fraser, H. O. Hill, C. H. Jennings, H. W. Pierce, G. N. Sieger, H. N. Simms and A. C. Weigel.

By Invitation: E. V. David and P. E. Kyle.

Staff Members: M. M. Kelly, W. Spraragen and L. M. Dalcher.

Lincoln Gold Medal

Revised paragraphs 3 and 5 of the regulations, as quoted below, were approved, subject to acceptance thereof by the donor and the Committee on Awards:

3. Award—The medal and certificate shall be awarded each year to the author of the paper which in the judgment of the Board of Awards is the greatest original contribution to the advancement and use of welding. When the paper selected for the Award is the product of more than one author, the medal and a certificate shall be awarded to the one author who, in the opinion of the Board of Awards, has contributed the major portion of the original work represented in the award paper, and a certificate shall be awarded to each coauthor. It is presumed that the Board of Awards will assign the award of medal and certificates, in such cases, only after due consultation with the authors and, where practical, with others who may be in a position to judge the relative contribution of each participant in the award.

5. Presentation—The medal, bearing on the reverse side the name of the recipient, and the certificate or certificates bearing the name of each author, shall be presented at a session of the Annual Meeting of the AMERICAN WELDING SOCIETY during the year for which the award is made. The presentation shall be made by the Chairman of the Board of Awards or by a member of the SOCIETY designated by the Chairman.

Finances

Statements covering financial operations of the SOCIETY for the six-month period ending March 31, 1946, were reviewed by the Treasurer. Specific mention was made of the following points:

Reduction in excess income over expense at the end of the six-month period, as contrasted with a year ago, which is due largely to increased activities and the cost of these operations. While the margin of excess income over expense is being narrowed gradually, this condition was expected and a close vigil will be kept over income and expense expectancies for the balance of the year.

Endowment funds for the Davis Undergraduate Welding Award and the Lincoln Gold Medal are included in cash and also shown under current liabilities, thus giving a clear picture of the amounts remaining in these accounts.

In regard to comparative consolidated statement of resources, attention was drawn to improvement in cash on hand and net worth this year, contrasted with a year ago.

Attention was drawn to the slight decrease in income in JOURNAL advertising for the month of March, compared with a year ago. It was explained that increased advertising rates for old advertisers had not yet become effective. The new rates will probably offset any loss in advertising. JOURNAL costs, however, are advancing and this item needs watching, as does also the drop in membership revenue.

Upon motion, duly seconded, it was voted to accept report of the Treasurer on the financial operations of the SOCIETY for the six-month period ending March 31, 1946.

To properly equip the Technical and Handbook offices of the SOCIETY, and to replace worn typewriting machines in other departments, request of the Treasurer for an additional appropriation for office equipment of the order of $1000, was granted.

On motion, duly seconded, budget for the 1946 Annual Meeting in Atlantic City, N. J., November 17–22, which was proposed by the Convention Committee and approved by the Finance Committee, was accepted.

Consideration was given to desirability of supplying the SOCIETY's publications, without charge, to disabled veterans during period of disability. In a particular case, a member in good standing at the time of joining the armed forces had writ-

Punch press frame repair-welded with 52 lb. of 3/8" Tobin Bronze by the Sutton-Garten Company, Indianapolis, Ind.

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ten in to say that while he has been honorably discharged, he is still under Veteran Hospital care because of 100% disability. He is not working and expects to be under hospital care for at least a year. He requested to be kept on the SOCIETY rolls as a member in good standing until his release.

On motion, duly seconded, it was voted to grant this man's request and to supply him with the SOCIETY's publication for a period of one year without charge, the matter to be reviewed again at the end of that period.

It was deemed fitting that the Section to which the above member belonged be informed of the Board's action so that it, too, might give him full consideration.

It was further voted to review similar requests that might come in from other disabled veterans in the light of the disposal made above in this first case.

1946 Annual Meeting

Chairman E. V. David reported as follows:

The Convention Committee learned that the Ambassador Hotel, Atlantic City, N. J., headquarters for 1946 Annual Meeting of A.W.S., had changed both ownership and management.

On May 20th, a delegation of the Convention Committee called on the Convention Manager, and the new Manager of the Ambassador Hotel. Both gave their assurance that all arrangements for public space, for the Annual Dinner, for the President's Reception and for other matters connected with our Annual Meeting, made last March with the previous management, would be carried out in detail.

It was learned that, two weeks after the first announcement was sent out on March 22nd from A.W.S. Headquarters to members, the Ambassador Hotel had been sold out. This hotel has 600 sleeping rooms and guaranteed A.W.S. 500. The great majority are double rooms. Actually, 550 room reservations were received and confirmed.

The Convention Bureau advised that, in addition, about 100 room reservations of A.W.S. members had been accepted by the Ritz Carlton Hotel, adjacent to the Ambassador Hotel, and a smaller number of A.W.S. room reservations had been made in other hotels. All hotels were confirming reservations as received and none were willing to hold blocks of rooms for a longer period unless guaranteed. In view of this situation, A.W.S Headquarters sent out a second notice to members about June 1st, urging those who did not have confirmed hotel room reservations already, to forward filled in application form to Convention Bureau, Atlantic City, immediately. There is every advance indication that the 1946 Annual Meeting will be very well attended.

As scheduled, certain members of the Convention Committee met with the Philadelphia Section A.W.S. Local Committee, the afternoon of May 20th. After bringing them up-to-date on the hotel situation, copies of the latest tentative technical program were distributed and discussed by E. Vom Steeg, Chairman, Program Committee. Attention was directed to vacancies in the presiding officers, left open purposely to permit the host Sections of A.W.S. to name local individuals who merited recognition. H. B. Seydel, Chairman, Local Committee, agreed to submit these names by June 15th. This has been done.

It was also pointed out that, to accommodate the unusually large number of technical papers offered, it had been necessary to schedule 24 technical sessions. This will require three simultaneous sessions for Monday morning. It was agreed that the medals, prizes and awards will be presented at the Annual Dinner on Thursday evening, instead of at the Opening Session. The Annual Dinner will be with music and finished with a keynote speaker on a timely topic to a mixed audience, similar in type to A.S.M. annual dinners. There will be no paid entertainment afterwards, except, possibly, dancing. This would reduce the cost of the dinner and the high tax on entertainment, while still providing a very enjoyable and successful occasion, it is believed.

H. B. Seydel stated he would give immediate attention to the selection of committee personnel on local arrangements. Registration, signs, technical sessions and local personnel for handling these activites were discussed. It was felt that plans for

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Ladies' Entertainment should be postponed until A.S.M. issues its program for this item. Plans for the President's reception, commencing at 5:00 P.M. Sunday, were reviewed again. The function of the Local Exhibit Committee in assisting the National Manufacturers Committee A.W.S., was explained.

The Local Committee was asked whether they felt that an A.W.S. booth in the Atlantic City Exposition would be desirable. They expressed themselves in favor of it and Mr. Seydel agreed to contact the other Sections of A.W.S in the district to obtain personnel to assist in manning the Booth during the week. It was pointed out that the Membership, Publication and Technical Activities Committees would be particularly interested in this booth. It was suggested that a special committee with H. O. Klinke, Associate Secretary A.W.S., as Chairman, be appointed to organize this activity properly. W. H. Eisenman has been approached and has agreed gladly to provide a suitable space for A.W.S. booth gratis.

The Convention Committee expects to meet again with the Philadelphia Section A.W.S. Local Committee in the early part of September.

Upon motion, duly seconded, the report of the Convention Committee Chairman was accepted. He was given a vote of thanks for his efforts in behalf of the Society.

Invitations from ASM

Invitation from A.S.M. requesting participation of the A.W.S San Francisco Section in the Western Metal Congress, to be held in San Francisco for one week commencing March 22nd, was considered. It was reported that A.S.M. had been contacted in respect to extending the invitation to include other A.W.S. Sections in the Pacific Coast District, and A.S.M. had offered no objection to such participation.

Accordingly, it was, upon motion, duly seconded, voted to refer A.S.M. invitation to C. P. Sander, Vice-President of the Pacific Coast District, with request that he (1) obtain the reaction of the Sections in his District to participation in the Western Metal Congress, with the understanding that the San Francisco Section will act as host in this instance and the other Sections assist in any manner possible, and with the further understanding that the District Vice-President will organize and supervise arrangements, in accordance with Article VI, Section 5, of the By-Laws; and (2) report back to the Board of Directors, at the earliest possible moment, in order that suitable reply can be made to A.S.M. on our participation in the Western Metal Congress.

Consideration was given next to a communication from A.S.M. informing us that the A.S.M. Board of Trustees has voted to hold the 1947 National Metal Congress and Exposition in Chicago the week of October 20th and to authorize the extending of an invitation to A.W.S. to participate in this Exposition on the same basis as in the past, with the same financial arrangement.

It was voted to accept with thanks report of Special Committee appointed to confer with Mr. Eisenman on improvement in arrangements for A.W.S. participation in the National Metal Exposition.

It was further voted to accept invitation of A.S.M. to participate in the 1947 National Metal Exposition and Congress, subject to approval of the Manufacturers and Convention Committees.

Welding Handbook

Mr. Klinke stated that he had received replies from 75% of the individuals invited to serve as chairmen of committees to prepare the various chapters. Acceptances are running high, with about six or seven to date having declined to serve. It is planned now to proceed with completing the personnel of the committees and shortly thereafter, work will commence on the preparation of the chapters.

Sectional Activities

Mr. Klinke reported that a visit was made to the Western Massachusetts Section, together with F. W. Davis, Vice-President of District 1. This visit was made at the request of the officers of the Western Massachusetts Section to assist them in strengthening and reactivating

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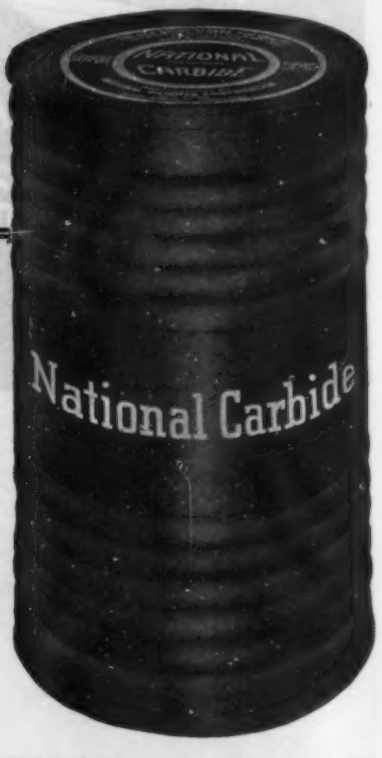

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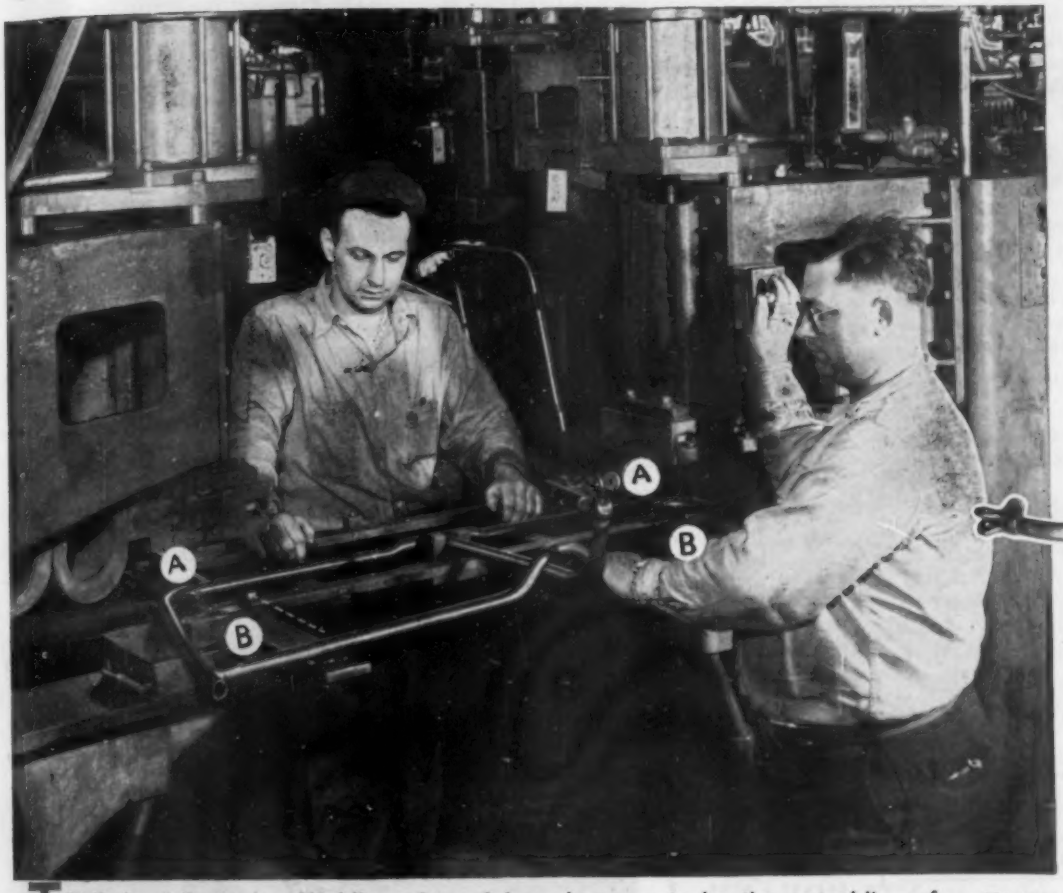
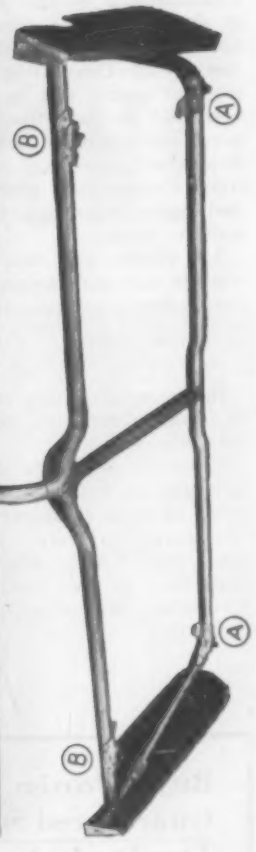
2400 Welds* Hourly on Federal AUTOMATIC RESISTANCE WELDERS





THE Federal Resistance Welding pictured here happens to be the assembling of studded brackets to a sliding seat frame, but the principle involved may well apply to some production of yours . . . the principle of getting the best possible juncture between two or more pieces of metal at the lowest possible cost.

In this case two Federal PA-2 press type welders are used as one projection welding unit. They are mounted on a single steel base for solid alignment, and synchronized with electronic controls to operate in unison. The dies are simple. Air-lift cylinders provide extra wide die opening for easy loading.

Brackets are dropped in each of the lower dies (A-A and B-B). The frame is then quickly positioned in dies A-A (no locking necessary). Seconds later, two brackets having become a part of the frame, the work is indexed in the direction of the dotted line and two more brackets welded (in dies B-B). Job is done in less than 30 seconds floor to floor, delivering 150 frames (600 brackets with 2400 welds) per hour.

These brackets are not merely "fastened" to the frame. They are a part of it, because resistance welding literally forges the two parts in a juncture stronger than the surrounding metal. That is one of the many superiorities of resistance welded fabrications.

This type of seat frame is automatically resistance welded throughout, and Federal provides welders for each operation . . . flash welding the tubular members, flash welding the Y-bracket and spot welding stampings to the frame.

**These are projection welds, four projections being stamped into each bracket. Thus eight welds (two complete brackets) are made during each cycle of this combination unit.*

Bulletin 4520 describes Federal Press Type Welders like those above. Bulletin SP-346 describes all types of resistance welders made by Federal.

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this Section to meet current needs.

Letters were addressed to all of the District Vice-Presidents requesting that they get in touch, either through a meeting or by mail, with their respective Section officers with a view toward setting up speaker circuits for those Sections located close enough to make this feasible.

A Committee is being formed under the Chairmanship of Mr. James F. Maine, of the Cleveland Section, to promote a Section Aid Meeting at the November Atlantic City Convention. A number of relevant points will be covered dealing with such Section activities as inspection trips, entertainment, handling of discussion following meetings, selection of Executive Committee, membership drives and many other proper functions of a well-run Section.

Mr. Klinke was complimented on his work to date and the reports of both activities were accepted with thanks.

Technical Activities Committee Recommendations

On recommendation of the Technical Activities Committee, the following actions were taken:

Canadian Standards Association Subcommittee on Welding Electrodes.—It was voted to approve appointment of S. A. Greenberg, Secretary, A.W.S.-A.S.T.M Committee on Filler Metal, as liaison representative to the Canadian Standards Association Subcommittee on Welding Electrodes.

Revised Specifications for Iron and Steel Gas Welding Rods.—It was voted to approve the adoption and publication as a tentative standard of A.W.S., the revised Specifications for Iron and Steel Gas Welding Rods.

A.S.A. Sectional Committee on Safety in Welding and Cutting.—It was voted to approve the appointment of S. A. Greenberg, Secretary, A.W.S. Committee on Safety Recommendations, as A.W.S. representative on the A.S.A. Sectional Committee on Safety in Welding and Cutting.

Participation of Local Sections in Technical Committee Activities.—It was deemed desirable to follow the recommendation of the Technical Activities Committee in encouraging the local Sections to designate a technical activities representative for the Section, whose function would be:

(1) to publicize in the Section information received from SOCIETY headquarters relative to the codes, standards and technical committee activities of the SOCIETY;

(2) to inform SOCIETY headquarters of any items of interest to the technical committees that might develop in the Section;

(3) to inform SOCIETY headquarters of competent personnel in the Section who are available for service on technical committees.

The President recommended that the Associate Secretary be kept informed, through copies of TAC minutes and reports, as well as letters transpiring between the Sections and the Technical Department, so that on his visits to the Sections he can serve as liaison officer between Sections and headquarters on standardization matters.

The President made reference to a request from the Los Angeles Section for assistance in bringing up to date the Los Angeles building code, in so far as welding is concerned. The Technical Secretary reported that request for such assistance, coming from the Building and Safety Commission of the City of Los Angeles, had been referred to him and he had complied by writing direct to the Secretary of the Building Commission, with copy to the Chairman of the Los Angeles Section, with a suggestion that a member of the Los Angeles Section work with the A.W.S. Technical Department toward the end of assisting the City of Los Angeles in adopting appropriate welding provisions.

The meeting adjourned at 1:30 P.M. for luncheon and reconvened at 2:30 P.M.

Educational Committee

Addition to Personnel.—On recommendation of Chairman Kyle, it was voted that R. H. Davies, in charge of educational activities of The Lincoln Electric Co., be appointed a member of the A.W.S. Educational Committee.

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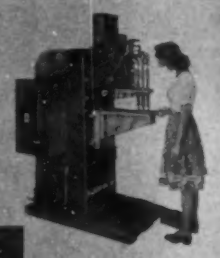

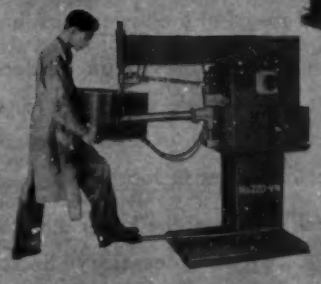

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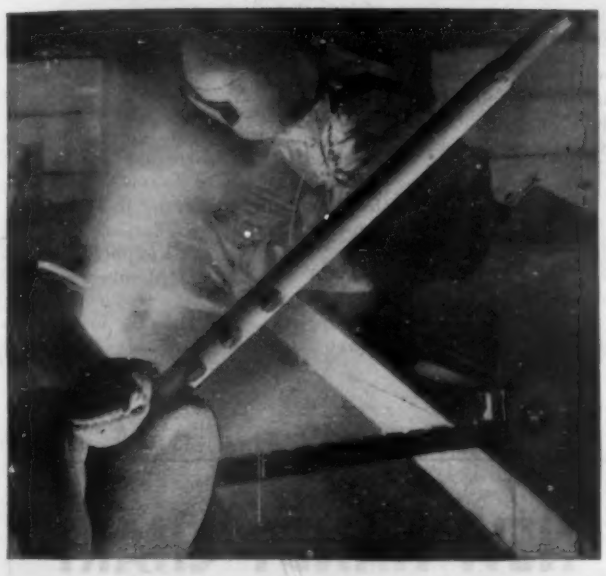

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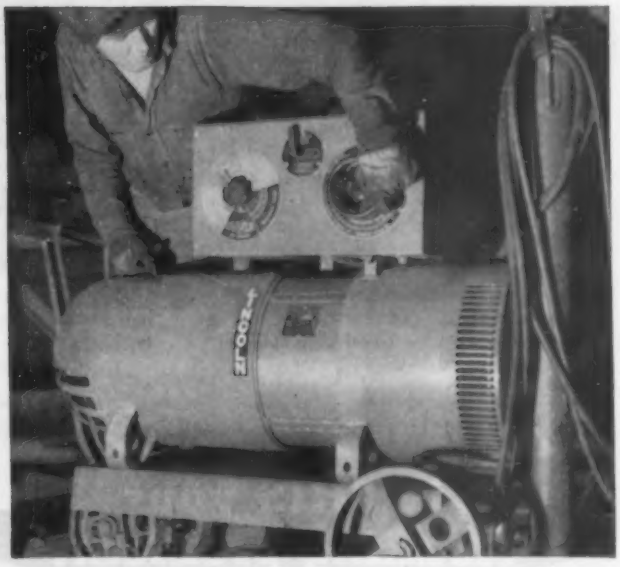

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ARC WELDING

It was agreed that W. J. Conley be continued as a member of the Committee for the present.

Activities.—Progress to date on matters in the hands of the Committee was reviewed by Prof. Kyle.

The *A. F. Davis Undergraduate Welding Award Program* was organized, the conditions of the contest were written with Mr. Davis' approval, a brochure was prepared by the A.W.S. Headquarters, copy for the certificate of award was sent to Mr. Davis and with his approval, the certificate is being prepared; the jury is now being organized and one entry has been received for the first contest year which ends July 1, 1946. The committee is considering a revision of the announcement for the next contest year in hopes of increasing the number of contestants.

A list of *Educational Movies on Welding* has been prepared for publication in THE WELDING JOURNAL and for distribution to the engineering schools and other educational institutions. This list will be kept as up to date as possible and revised lists will be issued from time to time.

The work on the *Survey of Textbooks* in the fields in which welding is introduced to engineering school students has been carried on and the publishers have been sent the comments of the committee on the books submitted. This survey will continue and the committee has offered to review manuscripts of new books and revisions with the view to offering constructive suggestions to the authors regarding the treatment of welding.

Before preparing a curriculum in welding engineering or descriptions of courses in welding to be sent out over the signature of the President of A.W.S., the committee feels that a detailed survey should be made of the courses and methods now in use by the engineering schools. This survey is now being organized and letters requesting information will be sent to the Deans of Engineering of accredited colleges and universities soon.

The President, in behalf of the Board expressed sincere appreciation to Prof. Kyle for the Committee's accomplishments of the past year and the hope that the Committee will continue this coming year to devote its attention to activities related to the engineering colleges and universities.

Canons of Ethics for Engineers

It was voted to approve the Canons of Ethics for Engineers, constituting a standard of professional conduct for members of A.W.S., submitted by the Committee on Code of Principles of Conduct.

Further, it was voted to publish these Canons in THE WELDING JOURNAL.

Columbus Section Welding Exhibit

Request of the Columbus Section for permission to sponsor a two-day welding exhibit at Ohio State University, October 11th and 12th, for the benefit of new students and small industrial users of welding in the central Ohio area, was discussed.

Since the Section is planning to put on an extensive membership drive at the time of the show, which normally is the time of the first meeting of the Section, and since the show is to be an exhibit of new welding procedures, rather than one of equipment and supplies, it was believed that the show will be helpful in advancing welding knowledge and enhancing the SOCIETY'S prestige in that area, without interfering with the National Welding Exhibit.

Accordingly, it was voted to authorize the Columbus Section to proceed with its plans for a two-day welding exhibit, as outlined in Mr. Shackleton's letter of June 3, 1946.

Membership Promotion

The Membership Committee Chairman reported that in an effort to stimulate interest in A.W.S. membership, it is proposed to issue a four-page letter size pamphlet, to supplement the membership folder entitled "Progressing in Welding," of which a supply of 8000 is in stock. On the outside cover of the pamphlet it is proposed to have an invitation to membership—a letter addressed to potential members and signed by the Membership Committee Chairman. On the inside pages will appear curve showing membership growth since date of organization, a

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graphic chart showing distribution of membership revenue and a column showing occupational breakdown. On the back cover are given reasons for belonging to A.W.S.

Although the format and copy of the pamphlet has been approved generally by the Membership Advisory Committee, Mr. Sieger stated that time had not permitted obtaining quotations on printing the pamphlet, but it is believed that funds appropriated in the current year's budget for membership printed material will take care of the cost. Channels of distribution are the Sections, Membership Committee and Headquarters. It was the opinion of the Board that the pamphlet is a remarkable piece of sales literature and, accordingly, authorized the Membership Committee Chairman to proceed with its printing.

Report on Visitation of A.W.S. Sections

President Hess highlighted his letter, dated June 8th, attached to the agenda of this meeting, and stressed particularly the importance of periodic visitation from Headquarters to the Sections. He believes it is good policy also for the President to visit each Section at least once every two or three years. He feels that visitation is the best means of settling problems confronting the Sections and explaining to them policies and the inner workings of the SOCIETY.

The Membership Committee Chairman made a plea for all officers and directors to call upon the Section officers, whenever they are passing through a town where a Section is located. This is particularly desirable in the case of the newer and smaller Sections, where encouragement is needed. In that direction, it was suggested that the Secretary have compiled a vest-pocket edition of a directory containing the names, business and residential addresses and telephone numbers of the National and Section Officers and the meeting dates of the Sections, for distribution among the officers and directors of the SOCIETY and its Sections.

Recognition of Welding Engineers

Serious thought was given to the problem described in communications from Prof. Hess, H. W. Pierce and H. M. Reinhard, all relating to recognition of welding engineers. While all were of the opinion everything possible should be done to protect the reputation of the welding industry and uphold the properly qualified engineers in the welding field, it was agreed that qualification and certification of a welding engineer is outside the scope of a technical or professional society. It is within the province of the SOCIETY to set up standard qualifications for a welding engineer, which can, if desired, be accepted by colleges, universities and industry.

With this in mind, it was, upon motion, duly seconded, voted to refer the subject to the Educational Committee for study with a view to setting up standard qualifications for a welding engineer and to request that the Committee report back to the Board of Directors; further, to request Headquarters to furnish the Educational Committee with data compiled by a former Educational Committee and in the files of the SOCIETY.

VAN DIVER OPENS OFFICE AS ADVERTISING COUNSELOR

Vernon H. Van Diver, one of America's leading authorities on trade and institutional advertising, has left Union Carbide and Carbon Corp. and opened his own business as merchandising and advertising counselor with offices in the McGraw-Hill Bldg., New York City. He will also head The Brad-Vern Co., advertising agency at Garden City, N. Y.

Mr. Van Diver has had broad experience in industrial and advertising fields ranging from sales and advertising work with Ingersoll-Rand Co. and associate editorship of *Compressed Air Magazine* to his now completed 18 years of advertising work for U.C.C. Units in the Alloys and Metals; Chemicals; and Industrial Gases and Carbide Groups. He is the author of *Brad-Vern's Primer* for Business Paper Advertising published in 1942, and with his sons, Bradford and Vernon, founded *Brad-Vern's Reports* now a division of *Printer's Ink*.

While with Union Carbide, Mr. Van

Diver directed the creation and placing of advertising for The Linde Air Products Co.; Oxweld Acetylene Co.; The Prest-O-Lite Co., Inc.; The Oxweld Railroad Service Co.; Electro Metallurgical Co.; Haynes Stellite Co.; Carbide and Carbon Chemicals Corp. and Dominion Oxygen Co., Ltd., in addition to the institutional advertising for the parent company, some of his campaigns winning top awards for advertising in the trade field.

MANZER JOINS PROGRESSIVE WELDER

Appointment of Clifford M. Manzer as chief engineer of Progressive Welder Co. has been announced by John D. Gordon, general manager of Progressive.

Mr. Manzer, who will be in charge of all engineering activities, comes to Progressive with a broad background of experience in connection with the design and operation of resistance-welding equipment of all types.

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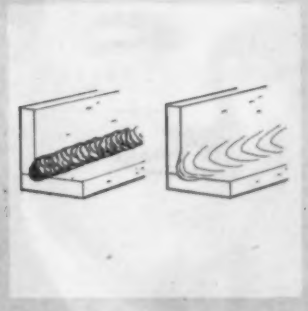
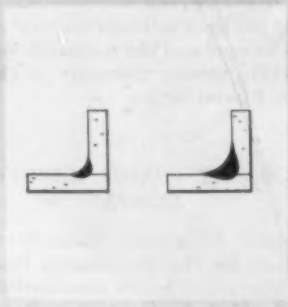
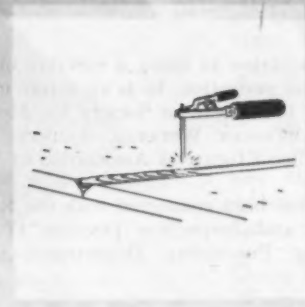
BETTER APPEARANCE

Here, too, DH-2 excels; weld metal "feathers out" neat and uniform. No notched effect along weld edges.





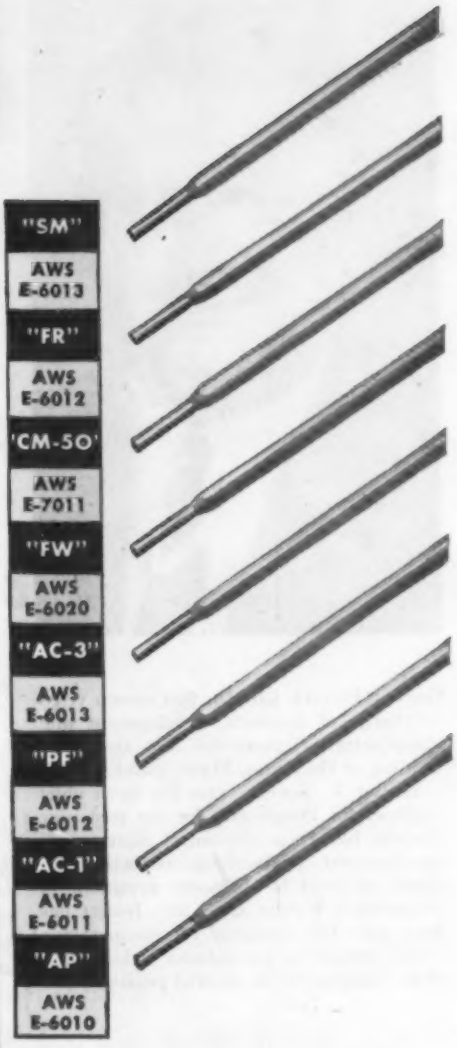


MEDIUM OR DEEP PENETRATION

You get what you want with this improved P&H Electrode. Weld at normal amperages for medium penetration . . . high amperages for deep penetration.

FOR DOWNHAND

DH-2 performs extremely well for all horizontal, flat fillet and groove welding. It's a downhand "specialist" that's winning out wherever it's tried.



P&H ELECTRODES MEET ALL NEEDS

These are but a few electrodes of the P&H mild steel group. There are types for *all* mild, alloy and stainless steel applications — for cast iron and for building up and hard surfacing.

P&H WELDING POSITIONERS

Cut handling costs — position work for easy downhand welding — use of larger electrodes. 2500 lb. capacity unit, Bull. P2-1; larger units, Bull. P1.

P&H

WELDING ELECTRODES
4551 W. National Ave.
Milwaukee 14, Wisconsin

HARNISCHFEGER CORPORATION
WELDING ELECTRODES • MOTORS • HOISTS • ELECTRIC CRANES • ARC WELDERS • EXCAVATORS

WELDING ELECTRODES | ELECTRIC HOISTS | DC WELDERS | AC WELDERS | WELDING PRODUCTION CONTROL SYSTEMS

General Electric Co., the last eleven years in charge of research, development and manufacturing processes on resistance welding at the Lynn, Mass., plant.

Walter L. Jewett, who has been chief engineer for Progressive for the past nine months has been appointed manager of development engineering, reporting directly to Fred H. Johnson, president of Progressive Welder Co. Mr. Jewett has been with the company for the past ten years, rising from a resistance welding machine designer to his present position.

SUSTAINING MEMBER

Lukens Steel Co., Coatesville, Pa., was established in 1810. Through the facilities of its open-hearth furnaces and plate rolling mills, including the 206-in. mill—world's largest plate mill—Lukens supplies plates of carbon and alloy steels up to 25 in. thick or up to 195 in. wide; also clad steel plates to over 3 in. thick, or up to 162 in. wide. Spinning machines in its flanging department form large one-piece heads to over 18 ft. in diameter; presses produce heavy pressed parts and heads; the services of a development engineering division are offered. Two subsidiaries, By-Products Steel Corp. and Lukenweld, Inc., specialize in steel plate shapes and weldments.

METROPOLITAN PURCHASERS' ASSISTANTS CLUB

Alfred A. Northacker, Supervisor of Follow-Up, The M. W. Kellogg Co., New York, N. Y., was elected vice-president of the above organization, on June 28, 1946, at their annual meeting. Mr. Northacker's duties will include supervising all functions of the Education, Program and Plant Visits Committees, as well as formulating plans for all extra-curricular activities.

In addition to being a member of the above organization, he is an active member of the American Society for Metals, the AMERICAN WELDING SOCIETY, and the Office Executives Association of New York.

He has been connected with the Expediting and Inspection Division of the Kellogg Purchasing Department since 1936.

AUSTIN MADE DISTRICT MANAGER

Herbert G. Austin, who has been assistant district manager of sales in the Boston Office of Lukens Steel Co. and Subsidiaries, By-Products Steel Corp. and Lukenweld, Inc., has been named district manager of sales of the Boston office, according to an announcement today by J. Frederic Wiese, vice-president in charge of

sales of the companies. Austin succeeds Robert H. McCracken who has been appointed district manager of sales of Lukens' and By-Products' newly opened sales office in Cleveland, Ohio.

Austin joined the Lukens organization in 1927 as assistant district manager of sales of the Boston office after serving successively as New England sales manager of Central Iron & Steel Co., and as assistant district manager of Lackawanna Steel Co., and with several smaller iron and steel concerns.

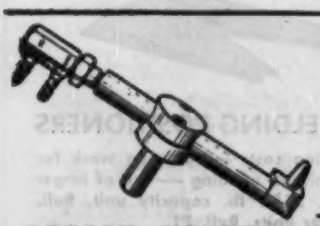
He has been active in the New England Iron League and the AMERICAN WELDING SOCIETY, serving currently as chairman of the Boston section.

ROBERT T. PURSELL JOINS KRIEG COMPANY

Robert T. Pursell, formerly welding engineer for the Worthington Pump and Machinery Co., is now associated with the Charles W. Krieg Co. of Newark, N. J.

In addition to manufacturing Kre-Co Multichemic Fluxes and Pre-placed Alloy Rings, the Krieg Co. is a leading distributor of welding equipment and supplies. Mr. Pursell will serve in the capacity as consultant to the Krieg Co. in the field of activities of that organization.

The background of Robert T. Pursell includes a degree from the Newark College of Engineering as well as the study of metallurgy at the Brooklyn Polytechnic In-

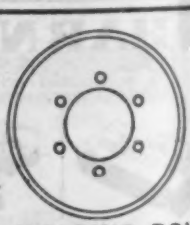


"ELECTROLOY" for RESISTANCE WELDING

Butt
Flash
Spot
Seam
Projection

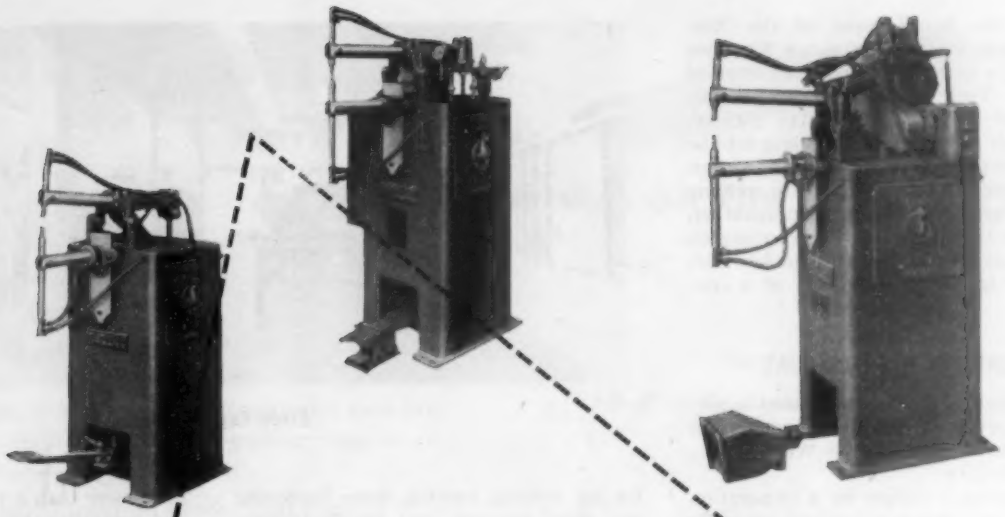
ELECTROLOY

Catalog and prices on request

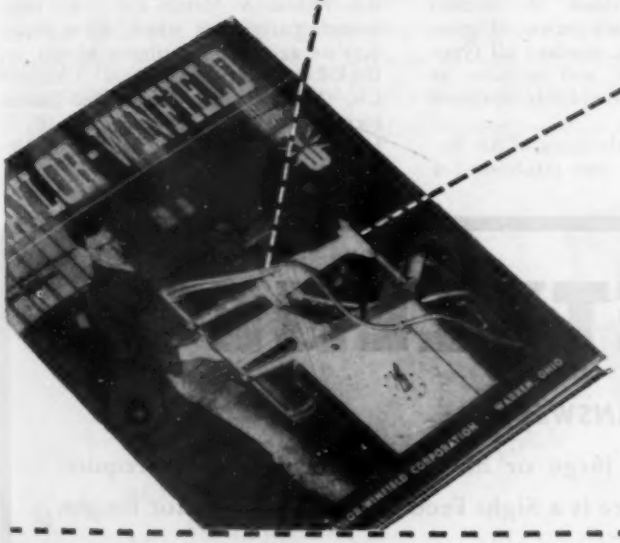


OFFSET HOLDER

THE ELECTROLOY CO. INC. 1600 SEAVIEW AVE. BRIDGEPORT, CONN. WELDING ROLL



Want to know more about SPOT ⊙ WELDING ?



What Can You Do with Taylor-Winfield Spot Welders?

You can join sheet metals in a variety of shapes . . . boxes, frames, grill work, wire products, kitchen ware, racks, automotive parts, radio cases. The new Taylor-Winfield Spot Welder bulletin shows you what you can do in terms of gauges, sizes, and types of material.

Are Taylor-Winfield Spot Welders Easy to Operate?

Skilled training not necessary. Three types available . . . foot, air, or motor operated. Once set and ready, a Taylor-Winfield Spot Welder gives you the same high quality of weld time after time, day in and day out.

Does Taylor-Winfield Make Different Styles of Spot Welders?

Yes. The popular types are rocker arm and press, and in addition we make several others for special work. This new bulletin discusses the rocker arm type but includes data useful on all spot welders.

MAIL COUPON today!

Name_____ Title_____

Company _____

Address_____

City_____ State_____

This new Taylor-Winfield Spot Welder bulletin contains 12 pages of useful information, covering such elements as speeds and welding times, electrode openings, styles of horns, specifications, descriptions and illustrations of spot welders and products made on spot welders. Send for your copy today.

The TAYLOR-WINFIELD CORPORATION
WARREN . . . OHIO

stitute. He is chairman of the New Jersey Section of the AMERICAN WELDING SOCIETY, a member and past chairman of the New York Section of the American Industrial Radium and X-Ray Society. During his 15 years in the welding field he has delivered many lectures to various engineering groups pertaining to welding and radiography. His recent resignation, following 13 years with the Worthington Pump and Machinery Co., makes him available to the welding field as a consultant.

AIRCO EXPORT DISPLAY

Airco Export Corp. has opened a permanent products exhibit in connection with its main offices at 33 West 42 St., New York City.

The exhibit is unique for a corporation of this type in that it is designed primarily to enable Airco Export to demonstrate its products to buyers and representatives from abroad.

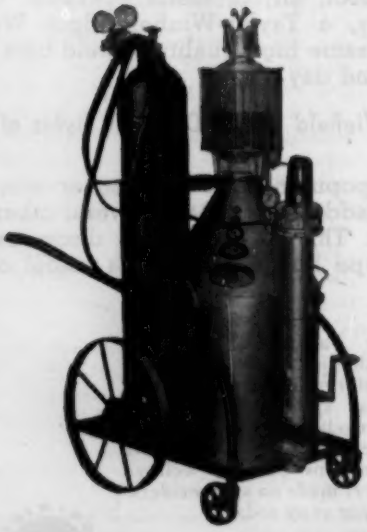
Of particular interest to the welding industry are the displays of Air Reduction Sales Corp. and Wilson Welder & Metals Co. Airco Export is the sole export distributor for both firms. One section is devoted to latest models of Hornet, Wasp and Bumblebee d.-c. and a.-c. Wilson welders; one includes a complete portable oxyacetylene welding and cutting outfit, and another shows the latest gas cutting machines—the Airco Radiograph, the Planograph, and the pipe-cutting machine, all completely equipped and operative except for the flame itself. All accessories for gas welding, cutting, flame hardening and flame cleaning, and for electric arc welding are displayed.

Airco Export Display

In addition to the welding and cutting group there are other exhibits. The alloy steel group contains an exhibit of Allegheny Ludlum stainless and electrical sheets. A chemical group includes many novel 3-dimensional displays, and ranges in products from insecticides through penicillin to ingredients for plastics, paper, rubber, inks and shoes. A medical equipment group, which proves of great interest to all visitors, displays all types of hospital equipment, and contains, as one of the exhibits, a completely equipped operating room.

Airco Export is a subsidiary of Air Reduction Co., Inc. It was established a little more than a year ago to consolidate and centralize the export business of Air Reduction subsidiaries, and to act as an international marketing agent for other prominent manufacturing companies. In one recent month it shipped products to 52 foreign countries. Among the Air Reduction group, whose products are handled by Airco Export, are the Ohio Chemical & Manufacturing Co., Air Reduction Sales Corp., National Carbide Corp. and Wilson Welder & Metals Co. Inc. Other manufacturers, for which Airco Export acts as agent or distributor abroad, are Beck-Lee Corp., Cameron Chemicals Co., the Englander Co., Hyland Laboratories, Sharples Chemicals, Inc., U. S. Industrial Chemicals, Inc., and Allegheny Ludlum Steel Corp.

NEED ACETYLENE?



HERE'S YOUR ANSWER!

No matter how large or how small your acetylene requirements may be—there is a Sight Feed Acetylene Generator for *you*.

With a Sight Feed you always have plenty of acetylene—never have to wait on delivery from a "bottler." Most important—the acetylene is there when you *need* it.

Remember too—a Sight Feed Acetylene Generator saves you up to 75% on acetylene costs.

Stop at your jobber's store today; he will be happy to give you the facts. Or write for fully illustrated booklet.

ACETYLENE GENERATORS · FLOODLIGHTS · FLARELIGHTS

ACETYLENE Sight Feed GENERATORS

THE SIGHT FEED GENERATOR COMPANY

RICHMOND, INDIANA

Welding cast iron?

Here's a way...

to get good welds on the toughest jobs

SEEMS as though there's no end to the fine reports we get on Ni-Rod.

Welding shops are using Ni-Rod for jobs they'd never tackle before. *Foundries* are using Ni-Rod to repair defective castings quickly and easily. *Maintenance men* are using Ni-Rod for time- and money-saving repairs of broken and worn castings.

Ni-Rod is even being used on production lines.

Why does one electrode find such broad use?

Because Ni-Rod welds are strong welds... sound welds ...machinable welds.

And... because Ni-Rod is the easiest-handling electrode ever developed for welding cast iron.

If you haven't tried Ni-Rod, order a package today... sizes are 1/8", 5/32" and 3/16". You'll find plenty of jobs for this electrode. Ni-Rod gives you a stable arc in all positions on either a.c. or d.c. Deposits are smooth, close to the color of cast iron and free from cracks and porosity.

Welders who use it, say, *"Ni-Rod is the easiest way to get the best welds in cast iron."*

Send for
Ni-Rod Instruction Booklet

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

NON-POROSITY was a "must" for this Ni-Rod repair job!

COMPANY
B. F. Goodrich Company, Akron, Ohio.

CASTING
One half of a steam-jacketed tire mold.

DEFECT
A thin section just above the steam and condensate ports.

PREPARATION OF THE WELD
The thin section was cut away until sound metal of at least ¼" wall thickness was found at all boundaries of the cut. A steel patch plate was then fitted into the opening. Edges of both plate and the surrounding cast iron were beveled to a vee of 75-90 degrees.

The entire half of the mold was preheated to 300° F.

WELDING
Using Ni-Rod, the inner and middle seams were welded and allowed to cool somewhat. Then, the outer seam was welded and lightly peened to counteract contraction stresses. Mold was allowed to cool slowly to room temperature.

TESTED
At 200 psi. water pressure.
At 100 psi. steam pressure.

COMMENTS
Several molds with similar casting defects have been repaired in this manner. No porosity has been detected. The welding has caused no appreciable distortion.

INCO NI-ROD

NI-ROD IS DISTRIBUTED BY:

WHITEHEAD METAL PRODUCTS COMPANY, INC.—Baltimore, Boston, Buffalo, Newark, New York, Philadelphia, Syracuse

WILLIAMS and COMPANY, INC.—Cincinnati, Cleveland, Columbus, Pittsburgh

STEEL SALES CORPORATION—Chicago, Detroit, Indianapolis, Milwaukee, Minneapolis, St. Louis

PACIFIC METALS COMPANY, LTD.—Los Angeles, San Francisco

J. M. TULL METAL & SUPPLY CO.—Atlanta

METAL GOODS CORPORATION—Dallas, Houston, New Orleans, Tulsa

EAGLE METALS COMPANY—Portland, Seattle

HENDRIE & BOLTHOFF MFG. & SUPPLY CO.—Denver

ROBERT W. BARTRAM—Montreal

ALLOY METAL SALES, LTD.—Toronto

WILKINSON COMPANY, LTD.—Vancouver

EUGENE W. O'ERIEN OF ATLANTA, GA., HEADS LIST OF NOMINEES FOR OFFICERS OF A.S.M.E. NEXT YEAR

Eugene W. O'Brien, vice-president of the W. R. C. Smith Publishing Co., Atlanta, Ga., has been nominated as next president of The American Society of Mechanical Engineers. Five regional vice-presidents representing various sections of the country, and four directors-at-large, also were nominated. Election of the nominees will be held by letter ballot of the entire A.S.M.E. membership of over 21,000 this coming fall, with the ballot closing on September 24.

Regional vice-presidents named are the following:

Alton C. Chick, assistant vice-president of the Manufacturers Mutual Fire Insurance Co., Providence, R. I., renominated from Region 1 to serve one year.

A. R. Mumford, development engineer with the Combustion Engineering Co., 200 Madison Ave., New York, newly elected from Region 2 for two years.

E. E. Williams, general superintendent of steam plants, Duke Power Co., Charlotte, N. C., renominated from Region 4 for two years.

T. S. McEwan, vice-president, McClure, Haddon and Ortman, Inc., Chicago, Ill., renominated from Region 6 for two years.

Linn Helander, professor and head of the department of mechanical engineering, Kansas State College, Manhattan, Kans., renominated from Region 8 for two years.

Directors-at-large named are:

F. S. Blackall, Jr., president and treasurer of Taft-Peirce Manufacturing Co., Woonsocket, R. I., for four years.

B. V. E. Nordberg, executive engineer, Nordborg Manufacturing Co., Milwaukee, Wis., for four years.

L. F. Moody, professor of hydraulic engineering, Princeton University, for two years.

W. A. Carter, technical engineer of power plants, Detroit Edison Co., Detroit, for two years.

PRESSURE WELDING TUBING

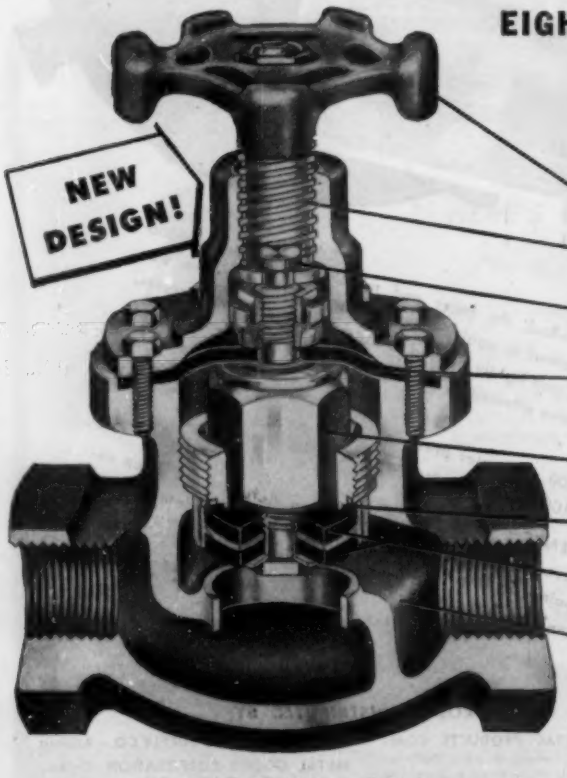
By using the oxyacetylene pressure-welding process, one manufacturer makes "tailor-made" boiler tubing of any desired length from standard tube stock. The tube lengths to be welded are clamped in the machine and subjected to hydraulic pressure and heat supplied from a special ring-type oxyacetylene heating head. In a short time plastic upsetting of the butted edges occurs, producing a weld of high quality. A close-up of the beginning of the plastic upsetting is shown in the illustration.

NATIONAL CHEMICAL SHOW AND A.C.S. CONVENTION TO BE HELD IN CHICAGO

With the Fourth National Chemical Exposition timed to be held during the period of the Semi-annual Meeting of the American Chemical Society, the eyes of the chemical world will focus on Chicago during the second week in September.

The show will open September 10 and continue through September 14 at the Coliseum. A.C.S. sessions will be held at the Palmer House, Stevens Hotel and in other downtown hostelries, all within a comparatively short distance of the exposition building.

The show is sponsored as heretofore by the Chicago Section of the American Chemical Society. Committees have been busy for months arranging details for the exposition which will be larger in number of exhibitors and in extent of display space than ever before.



EIGHT REASONS *why* YOU SHOULD SPECIFY...

REGO GLOBE *and* ANGLE VALVES

to eliminate hazardous and costly leaks!

1. **HANDWHEEL** . . . improved hand grip for easier operation.
2. **ACME THREADS** . . . quick acting, heavy-duty performance, longer engagement in bonnet.
3. **SWIVEL STEM** . . . gives vertical movement to seat disc, eliminates chances of seat scoring.
4. **DIAPHRAGM** . . . provides positive seal of valve stem, eliminating need of taking-up wear or repacking required with ordinary packed-type valve.
5. **SEAT DISC ALIGNMENT** . . . positive seating of disc assembly due to hexagonal guide.
6. **BACK SEATING** . . . permits replacement of diaphragm without shutting down line.
7. **SEAT DISC** . . . special long-life composition, positioned mechanically as there is no dependency upon springs.
8. **LARGE CHANNELS** . . . flow through valve is accomplished with minimum friction loss.

RegO Globe and Angle Valves are available in the following sizes: ¾", 1", 1¼", 1½" and 2"

The BASTIAN-BLESSING Company

4201 W. Peterson Ave. Chicago 30, Illinois

Pioneer and Leader In The Design and Manufacture of Precision Equipment for Using and Controlling High Pressure Gases.

MUREX TYPE HTS

The Right Electrode for Hard-to-Weld Steels

Developed primarily to prevent underbead cracking when welding high tensile steels without preheating, Murex Type HTS is an all-position rod providing weld metal of 70,000 psi tensile strength with ductility and X-ray soundness equal to that of welds made with downhand electrodes.

Because of its moderate penetration and low pick-up of undesirable elements from the parent metal, it is particularly useful in welding high-carbon, high-sulphur and other difficult-to-weld steels.

The complete facilities of our welding laboratory are available to help users of Murex electrodes achieve superior welds at lower costs. More detailed information on Type HTS or other widely-used Murex rods is available on request.

METAL & THERMIT CORPORATION

120 Broadway, New York 5, N. Y.

Albany • Chicago • Pittsburgh • So. San Francisco • Toronto

MUREX ELECTRODES

WELDING WIRE AGAIN DECLINES FROM PEAK*

Lessening of War Demands Shown in '45 Production

Production of steel welding wire during 1945 was an estimated 594,000,000 lb., a drop of 36% from the 1944 figure.

Last year's production, reflecting the curtailment of the production of welded war products, was approximately one-half that of the record output of 1943. In the latter year, almost 1,200,000,000 lb. of welding wire were produced by the steel industry.

*Taken from *A.I.S.I. Bulletin*, June 1946.

Ten pounds of steel welding wire were produced in 1945 for each ton of finished steel. This figure compares with 17 lb. per ton in 1943, and 5 lb. per ton in 1938 and 1940.

STAINLESS STEEL ELECTRODES

"Jessop Stainless Steel Welding Electrodes," just published by the Jessop Steel Co., Washington, Pa., contains complete information on the selection and application of Jessop stainless electrodes for welding stainless steel. Current range is furnished for each type of rod in varying diameters. Copies of this new 8-page booklet will be furnished upon request.

EDUCATIONAL FILMS

The Educational Committee of the A.W.S. has compiled the following list of movies and slide films on welding and allied subjects for use in engineering schools and other educational institutions as teaching aids. The list is based on the best information which the committee had available from suppliers of these films.

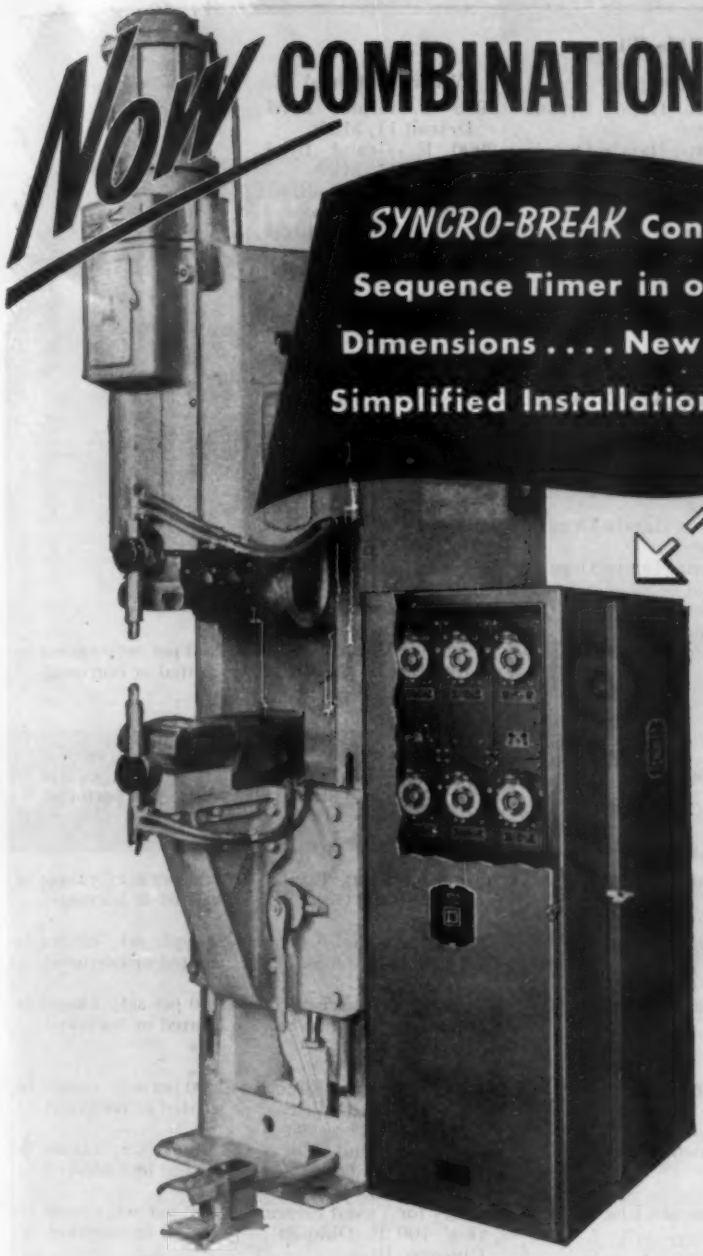
It would be very helpful if omissions could be brought to the attention of the Committee. As new films appear they can be added at a later date. Revisions of this list will be made at frequent intervals.

Movies

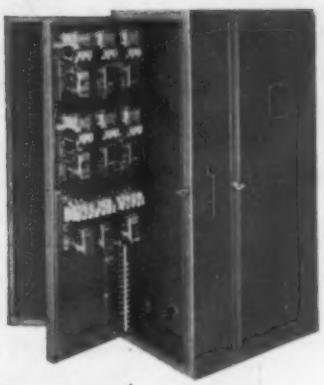
Title of Movie Film	Color Sound Size	Showing Time	Company	Where Obtained
The Inside of Arc Welding	Color, sound, 16 mm.	6 reels, 10 min. each	G.E.	G.E. Co., your district
The Inside of Atomic-Hydrogen Welding	Color, sound, 16 mm.	2 reels, 10 min. each	G.E.	G.E. Co., your district
This is Resistance Welding	Color, sound, 16 mm.	25 min.	G.E.	G.E. Co., your district
The Story of A.-C. Welding	Color, sound, 16 mm.	15 min.	G.E.	G.E. Co., your district
Welding of Aluminum (describing all types of welding)	Black and white sound, 16 mm.	20 min.	Aluminum Co. of America	Aluminum Co. of America, local branch
New Horizons in Welding	Black and white sound, 16 mm.		Harnischfeger Corp.	4400 W. National Ave., Milwaukee, Wis.
The Prevention and Control of Distortion in Arc Welding	Color, sound, 16 mm	20 min.	The Lincoln Electric Co.	12818 Coit Rd., Cleveland 1, Ohio
The Magic Wand of Industry—Arc Welding	Color, sound, 16 mm	25 min.	The Lincoln Electric Co.	12818 Coit Rd,. Cleveland 1, Ohio
Manufacture by Arc Welding	Black and white silent, 16 mm.	45 min.	The Lincoln Electric Co.	12818 Coit Rd., Cleveland 1, Ohio
Structrual Steel Welding	Kodachrome silent, 16 mm.	(400 ft.)	Air Reduction Sales Co.	Lincoln Bldg., New York 17, N. Y.
Oxyacetylene Welding of Red Brass Pipe	Kodachrome silent, 16 mm.	(350 ft.)	Air Reduction Sales Co.	Lincoln Bldg., New York 17, N. Y.
The Construction of The Airlines Terminal	Kodachrome silent, 16 mm.	(400 ft.)	Air Reduction Sales Co.	Lincoln Bldg., New York 17, N. Y.
Earthmoving Takes Wings	.....	.....	R. G. LeTourneau, Inc.	Peoria, Ill.
Introduction to Oxyacetylene Welding	Black and white sound, 16 mm.	20 min.	The Jam Handy Organization	2900 E. Grand Blvd., Detroit 11, Mich.
Installation of Continuously Welded Rail in Moffat Tunnel	Color, sound, 16 mm.	(400 ft.)	Metal & Thermit Corp.	120 Broadway, New York 5, N. Y.
Fabrication of Stern Frames	Color, sound, 16 mm.	(750 ft.)	Metal & Thermit Corp.	120 Broadway, New York 5, N. Y.
Fabrication of Heavy Parts by Thermit Welding	Color, sound, 16 mm.	(1000 ft.)	Metal & Thermit Corp.	120 Broadway, New York 5, N. Y.
Oxyacetylene Welding Light Metal	Black and white sound, 16 mm.	21 min.	USOE—Castle Films	30 Rockefeller Plaza, New York, N. Y.
Manual Cutting to a Line-Freehand	Black and white sound, 16 mm.	21 min.	USOE—Castle Films	30 Rockefeller Plaza, New York, N. Y.
The Guided Bend Test	Black and white sound, 16 mm.	17 min.	USOE—Castle Films	30 Rockefeller Plaza, New York, N. Y.
Preheating Welding and Stress Relieving	Black and white silent, 16 mm.	15 min.	Electric Arc Co.	152 Jelliff Ave., Newark, N. J.
Profits of Progress	Black and white sound, 16 mm.	10 min.	Intl. Acetylene Assoc.	30 E. 42nd St., New York, N. Y.
Prosperity Process	Black and white silent, 16 mm.	20 min.	Intl. Acetylene Assoc.	30 E. 42nd St., New York, N. Y.
Story of Arc Welding	Color, sound, 16 mm.	25 min.	U. S. Bureau of Mines	4800 Forbes St., Pittsburgh, Pa.
Welding	Black and white sound, 16 mm.	11 min.	University of Ill.	Urbana, Ill.
Unionmelt Welding—An Electric Welding Process, U-4	Black and white silent, 16 mm.	15 min.	The Linde Air Products Co.	30 E. 42nd St., New York, N. Y.
Unionmelt Welding in Industry, U-5	Black and white silent, 16 mm.	15 min.	The Linde Air Products Co.	30 E. 42nd St., New York, N. Y.
Unionmelt Welding in General Applications, U-7	Black and white silent, 16 mm.	15 min.	The Linde Air Products Co.	30 E. 42nd St., New York, N. Y.
Flame-Priming the Drum Gates of Grand Coulee Dam, B-8	16 mm.	15 min.	The Linde Air Products Co.	30 E. 42nd St., New York. N. Y.
Flame-Cutting of Billets and Bars, B-9	16 mm.	15 min.	The Linde Air Products Co.	30 E. 42nd St., New York, N. Y.
Flame-Hardening by the Oxyacetylene Process, K-2	16 mm.	30 min.	The Linde Air Products Co.	30 E. 42nd St., New York, N. Y.

Now COMBINATION WELDER CONTROL

SYNCRO-BREAK Contactor and Safront Weld Sequence Timer in one enclosure .... Standardized Dimensions .... New Safety Features .... Greatly Simplified Installation .... Improved Appearance



1. Complete automatic control system in one cabinet—necessary control fuses, terminals, transformers, etc. included.
2. Specifically designed to meet new standards and recommendations of RWMA and machinery builders.
3. Front location puts dials within easy reach to facilitate machine set-up or time adjustments.
4. Depth standardized at 20 inches, width kept within 15 inch maximum.
5. Foot switch, pressure switch, no-weld switch and timer control circuits are 110 volts for added operator safety.
6. Panel space provided for low voltage control or two-position foot switch auxiliaries.



Safront panel swung out to show timing and sequencing relays. Adjusting dials are on front of this panel for maximum safety. Separable connector strip allows easy removal of panel for installation or maintenance.

Side door gives access to contactor, control fuses, and all line, load, and control terminals. *SYNCRO-BREAK* rheostat is mounted on extended bracket to bring adjusting knob out beyond live parts.

***for complete information,* write Square D Company, 4041 N. Richards Street, Milwaukee 12, Wisconsin**

SQUARE D COMPANY

DETROIT • MILWAUKEE • LOS ANGELES

Slide Films

Title of Slide Film	Size	Showing	Company	Where Obtained	Comments
Cluster Welds	35 mm.	30 pictures 32 frames	The Jam Handy Organization	2900 E. Grand Blvd., Detroit 11, Mich.	
Fillet Welds—Steel	35 mm.	75 pictures 24 frames	The Jam Handy Organization	2900 E. Grand Blvd., Detroit 11, Mich.	
Fuel and Oil Tank Repairs	35 mm.	29 pictures 32 frames	The Jam Handy Organization	2900 E. Grand Blvd., Detroit 11, Mich.	
Flat Butt Welds	35 mm.	45 pictures 47 frames	The Jam Handy Organization	2900 E. Grand Blvd., Detroit 11, Mich.	
Introduction to Welding, An	35 mm.	68 pictures 64 frames	The Jam Handy Organization	2900 E. Grand Blvd., Detroit 11, Mich.	
Qualification Test for Welders	35 mm.	69 pictures 59 frames	The Jam Handy Organization	2900 E. Grand Blvd., Detroit 11, Mich.	
Setting Up and Lighting the Welding Torch	35 mm.	58 pictures 65 frames	The Jam Handy Organization	2900 E. Grand Blvd., Detroit 11, Mich.	
Tube Welds—Steel	35 mm.	71 pictures 58 frames	The Jam Handy Organization	2900 E. Grand Blvd., Detroit 11, Mich.	
Vertical Welds—Steel	35 mm.	38 pictures 41 frames	The Jam Handy Organization	2900 E. Grand Blvd., Ditroit 11, Mich	
Welding Aluminum Flat Sheets	35 mm.	64 pictures 69 frames	The Jam Handy Organization	2900 E. Grand Blvd., Detroit 11, Mich.	
Welding Aluminum Tubes with Sheets	35 mm.	49 pictures 32 frames	The Jam Handy Organization	2900 E. Grand Blvd., Detroit 11, Mich.	
Welding Flat Ripples	35 mm.	31 pictures 35 frames	The Jam Handy Organization	2900 E. Grand Blvd., Detroit 11, Mich.	
Welding Stainless Steel	35 mm.	34 pictures 38 frames	The Jam Handy Organization	2900 E. Grand Blvd., Detroit 11, Mich.	
A. Arc Welded Construction of a Revolutionary Type of Industrial Building Which Entirely Ignores Roof Trusses	35 mm.	41 pictures	The Lincoln Electric Co.	Society for Visual Education, 100 E. Ohio St., Chicago, Ill.	$2.00 per set; cannot be rented or borrowed
B. Cost and Weight Comparisons of WeldedSteel and Castings (Discussion of Advantages of Welded Construction)	35 mm.	37 pictures	The Lincoln Electric Co.	Society for Visual Education, 100 E. Ohio St., Chicago, Ill.	$2.00 per set; cannot be rented or borrowed
C. The Shielded Arc Process of Electric Welding	35 mm.	40 pictures	The Lincoln Electric Co.	Society for Visual Education, 100 E. Ohio St., Chicago, Ill.	$2.00 per set; cannot be rented or borrowed
D. Greater Profits in Manufacturing by Redesign	35 mm.	46 pictures	The Lincoln Electric Co.	Society for Visual Education, 100 E. Ohio St., Chicago, Ill.	$2.00 per set; cannot be rented or borrowed
E. Better Building and Structures at Lower Cost by Electric Welding	35 mm.	49 pictures	The Lincoln Electric Co.	Society for Visual Education, 100 E. Ohio St., Chicago, Ill.	$2.00 per set; cannot be rented or borrowed
F. Building Better Pipe Lines Faster and at Less Cost	35 mm.	34 pictures	The Lincoln Electric Co.	Society for Visual Education, 100 E. Ohio St., Chicago, Ill.	$2.00 per set; cannot be rented or borrowed
G. Surfacing by Electric Welding—An Opportunity for Big Savings	35 mm.	44 pictures	The Lincoln Electric Co.	Society for Visual Education 100 E. Ohio St., Chicago, Ill.	$2.00 per set; cannot be rented or borrowed
H. Automatic Arc Welding by the Electronic Tornado	35 mm.	43 pictures	The Lincoln Electric Co.	Society for Visual Education, 100 E. Ohio St., Chicago, Ill.	$2.00 per set; cannot be rented or borrowed
I. Safety and Health in Arc Welding	35 mm.	53 pictures	The Lincoln Electric Co.	Society for Visual Education, 100 E. Ohio St., Chicago, Ill.	$2.00 per set; cannot be rented or borrowed
J. Better Products and Lower Production Costs with the Modern Arc Welding Technique	35 mm.	32 pictures	The Lincoln Electric Co.	Society for Visual Education, 100 E. Ohio St., Chicago, Ill.	$2.00 per set; cannot be rented or borrowed
K. Lower Tooling Costs with Arc Welded Steel Jigs and Fixtures	35 mm.	34 pictures	The Lincoln Electric Co.	Society for Visual Education, 100 E. Ohio St., Chicago, Ill.	$2.00 per set; cannot be rented or borrowed

KODAK DATA BOOK ON FORMULAS AND PROCESSING

A third revised edition of the *Kodak Data Book on Formulas and Processing* has just been announced by the Eastman Kodak Co.

Containing a comprehensive list of Kodak formulas, together with a discussion of the principles and procedures for processing films, plates and papers, the new edition incorporates a number of changes to bring it up to date, plus a new section on Negative Faults—how to recognize them and identify their cause—and the formula for the new Kodak Quinone-Thiosulfate Intensifier IN-6 for use with very weak negatives.

Designed and punched to replace earlier Formulas and Processing sections in the *Kodak Reference Handbook*, this booklet is the first of the Kodak Data Books to incorporate the company's new method of designating Data Book revisions. Major revisions—as in this case—will be marked Third (Fourth, Fifth) Edition on both cover and page one. These replace corresponding Data Books carrying no edition designations as well as those with lower edition numbers.

When a Data Book is reprinted with minor changes, the edition number and the copyright date will not be changed, but the printing date will be added, for example: Third Edition, 1947 Printing. In either case, a description of the changes made since the last printing will appear inside the front cover of the Data Book.

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ONCE YOU START using the Kodak Transfax Process, you eliminate hand scribing on plate or sheet materials . . . avoid the expense of human error . . . accomplish in minutes the work of hours by hand.

This fast process duplicates translucent or transparent original drawings on metal, plastic, or similar nonporous surfaces, in three steps:

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Industrial Photographic Division
Rochester 4, N. Y.

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Kodak

COMMUNICATION TO THE EDITOR

June 5, 1946

The Editor
THE WELDING JOURNAL
New York, New York

My dear Sir:

Arc welding has been of decisive importance to America. Arc welding did more than most other manufacturing processes in the producing of the tools of war during World War II. Arc welding has produced a record for reliability in billions of welds, made over many years, that is unmatched by any other manufacturing process, yet arc welding is being attacked in a way which is tremendously handicapping its application, and promises still more to interfere with its future use.

This attack is aimed not at the process, as such. It is obvious such tactics would fail. The attack consists in throwing suspicion on the process by writing into specifications expensive and impractical tests which have little to do with the excellence of the weld. Most of them have to do with infinitesimal variations of no possible importance, but of great cost. The attack has already eliminated the economic use in many proper applications. If continued, it will soon eliminate many others.

We see, for instance, the ruling that welds must be X-rayed, which increases the cost by several times, yet the commercially welded joint is always of greater strength than the parent metal and is tremendously stronger than any riveted joint, where X-raying never has been suggested.

We see riveted joints which are made tight by caulking. This process is accepted without question. The resulting undercut is enormous, yet a welding undercut that is infinitesimal is frequently made the reason for rejection of welds.

We see welds chipped out, rewelded, and welded vessels rejected because of trifling defects such as infinitesimal porosity either on the surface or beneath, yet parent metal in the same structure with defects much greater, and whose weakening effect would be tremendously more serious, are accepted without question.

We see welding electrode specifications being written which enormously increase the cost of production with no increase in either the reliability nor in the excellence of electrodes. Rivets have no such test to handicap them.

While welding electrode is tested in every conceivable and nonsensical way, no one suggests any test on a rivet, yet the riveted joint is always the weakest spot in any structure. This is never true of a full-sized welded joint.

Much time and expense is used in testing electrode deposit to make sure it has great ductility and the weld is rejected if the ductility is low, yet riveted joints have no elongation and are accepted without question.

The contour of the deposit of a weld is a matter of very close inspection, yet no one examines the contour of any rivet or the hole it only partially fills.

All insured vessels must have their welds X-rayed and any weld is rejected if any infinitesimal defect is found, yet no one X-rays a riveted joint nor rejects it because of the voids between the rivets and the rivet holes which are known to be always present.

Because of the higher elastic limit of the weld metal, there is no load that can be put on a welded structure in which the weld is of equal or greater section than the parent metal which can affect the weld in any possible way until great distortion of the rest of the structure has taken place. Such distortion would make that structure valueless for its intended purpose, yet all this testing and rejecting listed above is made mandatory in many welded structures—never in riveted structures.

Further instances of the same kind can be cited by the scores. The examples shown are sufficient for the author's purpose.

Welding over the years has done a more reliable job than the rivets it has replaced. That record is conclusive. The engineering profession, which relies so completely on welding in so many cases, must recognize and resist this studied attempt to eliminate the arc welding process. The attack has already eliminated the economic use of welding in many structures. The success of such an attack on this tremendously valuable method is neither good advertising for the intelligence of the engineering profession nor good ethics for those involved in the attack. It is time we dealt with reality.

Very truly yours,
(Signed) J. F. LINCOLN
President, The Lincoln Electric Co.

SCIAKY ISSUES HOUSE ORGAN

A new Sciaky house organ entitled "Resistance Welding at Work" will be issued monthly and is to be primarily devoted to step-by-step analyses of interesting problems in Resistance Welding fabrication.

All those interested will be gladly placed on the mailing list. Address Sciaky Bros., Inc., 4915 West 67th St., Chicago, Ill.

BULLETIN ON CAMOGRAPHS

The Air Reduction Sales Co., New York City 17, has published a new bulletin describing its Airco Camographs Nos. 4 and 5 oxyacetylene cutting machines.

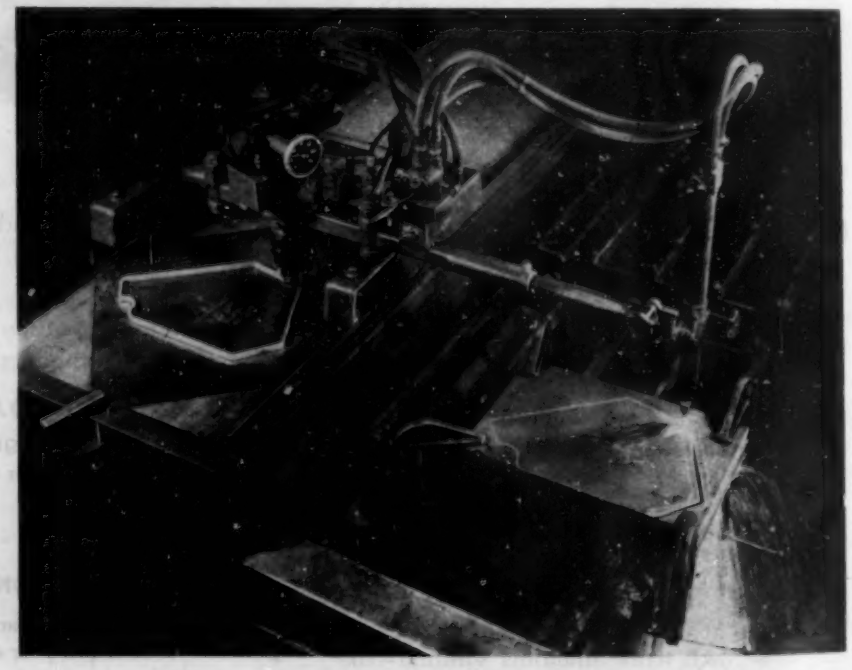
The bulletin covers specifications, operating instructions and electrical requirements. The Camograph bulletin is complete with illustrations of both machines and has color diagrams of their respective cutting ranges.

STAINLESS STEEL AND ELECTRODE CORRELATION CHART

A large-sized data sheet, folding into an $8\frac{1}{4}$ x 11-in. cover, lists every well-known stainless steel by trade name with the proper Arcos alloy electrode for welding each. A.I.S.I. type numbers and analyses of the trade-named stainless steels are given, as well as the weld metal chemical analysis of the corresponding Arcos electrodes. A copy of this correlation chart will be sent to you on request. Arcos Corp., 312 Gulf Bldg., Philadelphia 2, Pa.

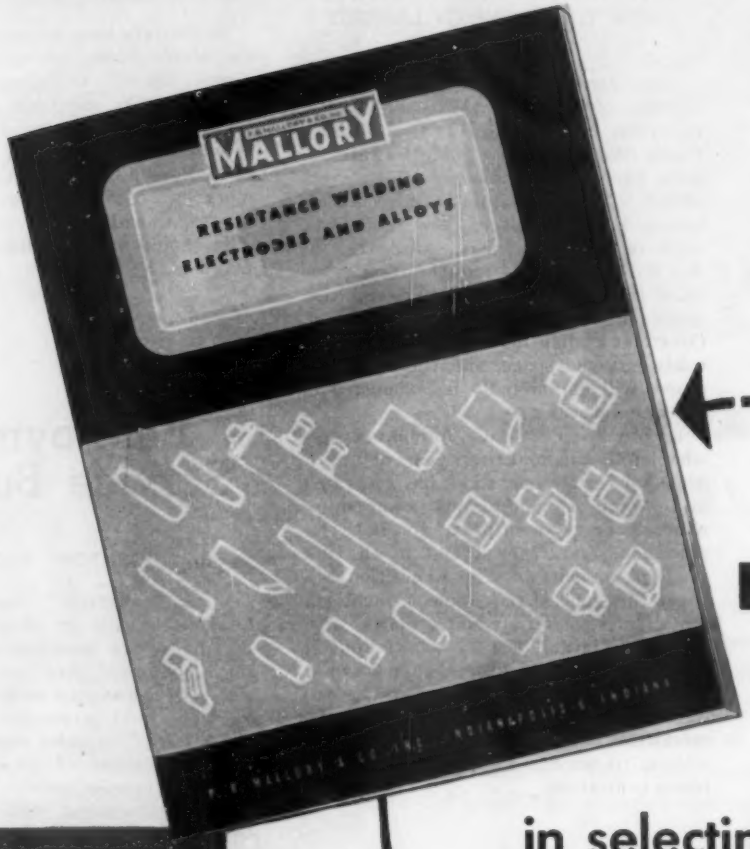
STACK CUTTING

Stack cutting with a mechanized templet-guided setup has become a popular production method for repeating irregular flat shapes. Fourteen pieces of $\frac{3}{16}$-in. steel plate are being cut at one time in the above illustration. Cutting speed is 7 in. per minute. The use of a standard aluminum strip templet to guide the machine through the cutting operation assures the accuracy of such work.



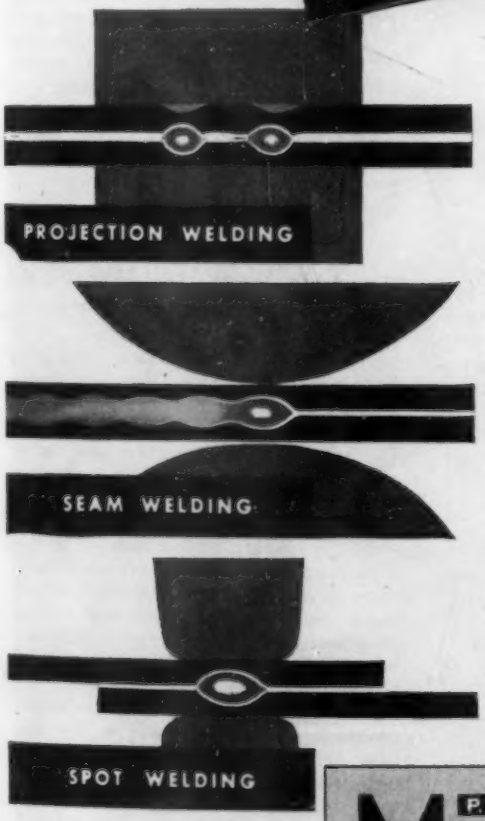
Courtesy Linde Air Products Co.

Stack Cutting



HERE'S FAST HELP

in selecting the right resistance welding alloys, electrodes and holders



HERE'S complete information on Mallory welding tips, water-cooled holders, replacement parts, electrode materials, seam welding wheels, flash and butt dies, alloy applications—facts, figures and dimensions on standard equipment that will help you do a better job.

If the catalog leaves you in doubt about the type of electrode or material you need, it also contains a questionnaire so our engineers can give you individual help. Write for a free copy of *Mallory Resistance Welding Electrodes and Alloys.*

In the United Kingdom, made and sold by MALLORY METALLURGICAL PRODUCTS, LTD. (An Associate Company of Johnson Matthey & Co. Limited) Hatton Garden, London, E.C.1

P.R. MALLORY & CO. Inc.

MALLORY STANDARD RESISTANCE WELDING ELECTRODES

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

SUITING THE HEAT TREATMENT TO THE JOB

Of particular interest and value to the younger metallurgists and to all heat treaters, as well as to production engineers and designers, is the simple, straightforward discussion of the fundamentals of heat treatment just prepared by the Research and Technology Department, Carnegie-Illinois Steel Corp., United States Steel Corp. Subsidiary. This 2-color, 8½ x 11-in. wire-bound, 54-page booklet, effectively illustrated with clearly explained charts, diagrams and photographs, devotes 26 pages to factors concerning Hardness, covering heating, pearlite, bainite, martensite, S-curve, hardenability and quenching. The next 26 pages relate to Toughness, covering such factors as tempering, shape of piece, notch-bar, austempering, stresses and cracking. Six concise fundamental statements summarize the detailed explanations, and a valuable table of Jominy end quench distances vs. bar diameters for six different quenching conditions concludes this new booklet. Copies may be secured from any office of American Steel and Wire Co., Carnegie-Illinois Steel Corp., Columbia Steel Co., National Tube Co. or Tennessee Coal, Iron and Railroad Co.

ELECTRONICS IN INDUSTRY

Electronics in Industry, by George M. Chute, Application Engineer, General Electric Co. Price $5.00. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York 18, N.Y.

This book describes and explains a wide variety of electronic equipment used in industry, for the man with little technical training. It explains vacuum tubes, complete tubes working in proved circuits, and, revealing the "magic" of electronics, shows how each part of the circuit acts during the split second. Circuits are traced in terms of electron flow instead of the conventional current flow, and new standardized symbols are followed. With dozens of examples of increasing complexity the book shows how tubes and tube-operated circuits work in many kinds of industry and shows circuit fundamentals in action.

ELECTRONIC CONTROL OF RESISTANCE WELDING

Electronic Control of Resistance Welding, by George M. Chute, 389 pages, 6 x 9, 152 illustrations. Price $4.00. Published by McGraw-Hill Book Co., 330 West 42nd St., New York 18, N. Y.

This book is an unusually simple and practical manual, fully explaining the tubes and circuits used to control resistance welders in industrial plants, for the aid of men who work with and maintain these controls. It describes electron tubes and their circuits, giving simple electrical background along with detailed explanation and diagrams of most tube circuits, including synchronous timers and stored energy controls—and shows how and why the tubes work in their circuits.

SEVENTEENTH NATIONAL POWER SHOW TO BE ONE OF LARGEST EVER HELD

Organization of the 17th National Exposition of Power and Mechanical Engineering, better known as the National Power Show, has been going forward for some time and is now practically completed. The Exposition will return to Grand Central Palace, New York, the week of Dec. 2–7, next, same week as A.S.M.E. meetings—for the first time since 1940. All the available exhibition space on four floors will be occupied. Over 300 leading manufacturers have already engaged space, and the remaining spaces will undoubtedly be exhausted in the near future.

Reconversion of industrial plants everywhere, following four to six years of forced-draft emergency operation, has generated an enormous demand for new power equipment of every description, for both replacement and renewal and in the full range of capacities. The Exposition will cover this general requirement, including units, parts, materials and supplies, with one of the largest displays of its kind in many years, both in space occupied and in number of exhibitors. The showing will consist principally of equipment for the production of power from fuel, power transmission to machines and some phases of power utilization.

BYERS SERVICE BULLETIN

A. M. Byers Co., Pittsburgh, announces that a service bulletin covering recommended practices for welding and flame cutting of wrought-iron pipe and flat rolled products now is available for distribution. Pioneers in the development of radiant heating and automatic snow melting systems, the Byers Co. states that proper welding procedures are important in the fabrication of such systems, as well as for installation of other wrought-iron piping services in the plumbing, heating, ventilating and refrigeration fields. The book contains a comprehensive welding chart that can be removed and tacked on a wall.

COMPARATIVE BRONZE ELECTRODE CHART PRODUCED BY AMPCO

Ampco Metal, Inc., Milwaukee 4, Wis., is distributing a "Comparative Bronze Electrode Chart," which contains the A.W.S.-A.S.T.M. classification of bronze electrodes and the grade numbers of arc-welding rods produced by 15 manufacturers which meet various classifications.

This chart gives a graphic over-all picture of the electrodes available in the bronze field and permits the user to select a type of rod that closely meets his requirements. Trade names and numbers are listed for proper identification.

Copies of this new chart will be sent on request to Ampco Metal Inc., Milwaukee 4, Wis.

AMERICAN ARC WELDING PATENTS

In the June issue we reviewed a book on the above subject edited by Mr. W. H. Simon, Ph.D. Arrangements have been made to make this book available in the United States. Copies of the book may be obtained through The Modern Technical Book Co., 55 West 42nd St., New York 18, N. Y. There was a slight error in the Canadian address of the book. This should read as follows: McAinsh & Co., Ltd., 388 Yonge St., Toronto.

Employment Service Bulletin

POSITIONS VACANT

V-192. Wanted. Applied Welding Engineer who is an all-around gas and electric welder, graduate mechanical engineer preferred, but not essential. A man of above average ability and with the experience and personality to work with and instruct the sales representatives of this organization. Address replies to the above box number.

V-193. Technical Editor and Field Secretary wanted. Desire competent welding expert to act as Editor of technical books and literature and to establish cordial relations with headquarters in New York and local representatives throughout the country. Age 38-40. Salary to start, $6,000. Prefer a man thoroughly familiar with operations of sections of a technical society.

SERVICES AVAILABLE

A-526. Welding Engineer. Ph.D. in Metallurgy. Age 25, married. Four years research in resistance welding of light alloys in famous eastern university welding research laboratory. Author of several articles on resistance welding. Experienced in organization and supervision of research programs. Desires position in eastern or midwestern industrial research laboratory, salary $5000.

A-527. Welding Supervisor. Major in Metallurgy. Ten years pre-war experience in all phases of welding. Knows Sales. Specialized shop and field welding of pressure vessels, power piping, refineries. Some knowledge of piping design. Write box number given above.

A-528. Foreman and Inspector desires position. In Welding trade for 11 years, have held positions as welding foreman, technician, inspector, welder, field inspector in charge of welders, testers, chippers, fitters and have made specifications for pipe lines, storage tanks, buildings. Have worked in Central America on various types of steel construction. Can furnish best of references. Am 28 years old and free to travel. Prefer to work outside Continental U.S.A. Am a native American, residing temporarily in Cuba and am able to come to the United States to accept employment.

FOR INDUSTRIAL RADIOGRAPHY

THE MACHLETT IR-220

This powerful, but compact 220 PKV industrial radiographic tube is exceptionally well suited for operation in oil-insulated, cable-connected, shockproof tube heads. Advanced features of design afford ample beam intensity at lower voltages and the ability to safely withstand operation at 220 PKV. Thus, an X-ray tube is provided with an unusually wide range of applications capable of handling most equipment subject to X-ray inspection.

1. Hooded anode inhibits wall bombardment and stem radiation. Inside of tube is field-free, making possible a constant electron stream and assuring stable operation.
2. Malleable beryllium X-ray port in anode hood reduces inherent filtration of useful X-ray beam to a minimum.
3. Two focal-spot sizes: 2.3 mm for maximum detail, and 5.0 mm for maximum continuous loading.
4. Anode is one-piece vacuum-cast copper with tungsten target; duct for cooling oil cast integrally.
5. Cooling and insulation, oil.

For full details, write Machlett Laboratories, Inc., Springdale, Connecticut.

IR-220 RATINGS

Maximum voltage, 220 PKV.

Maximum Energy, continuous operation:

IR-220-B 2.3 mm focal spot		IR-220-E 5.0 mm focal spot	
PKV	MA	PKV	MA
220	6.0	220	15.0
200	6.5	200	16.5
150	8.5	150	22.0
100	13.0	100	33.0

MACHLETT

X RAY TUBES SINCE 1897

TODAY THEIR LARGEST MAKER

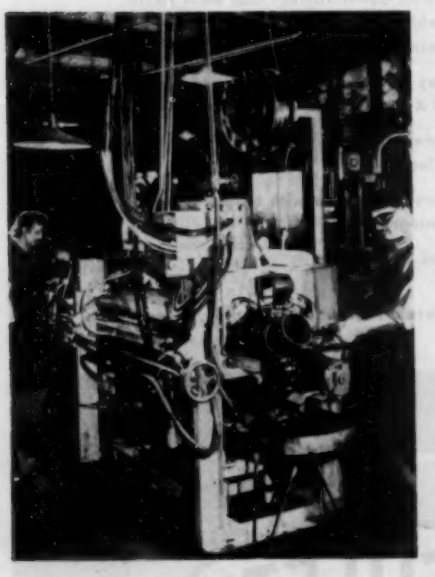
NEW PRODUCTS

The Society assumes no responsibility for the validity of claims in this Section

FIXTURES FOR CONTINUOUS SEAM WELDING OF ROUNDS, SQUARES AND OTHER SHAPES OF TUBES AND TANKS

A fixture, created because of an urgent war need for unlimited quantities of 75-mm. and 105-mm. shell containers, is now ready to speed up production in seam welding of rounds, squares and other shapes of tubes and tanks.

In this new type of fixture, the old conception of clamping the work in a fixture and then moving the automatic welding head along the seam, then breaking the weld, unclamping the old work, clamping up the new and repeating this process with its expensive and time-consuming delays has been discarded. The welding head in the new method remains stationary and the work moves under the head in a continuous moving stream making truer, straighter weld with less buckling of the metal.



The Victory Automatic Seam Welder has a variable speed range of from 60 to 150 in. per minute of weld. The drive includes "reversing" and "inching" controls. Speed can be altered while the work is in motion. The fixtures have a very steady, smooth action throughout.

These continuous welding fixtures operate in the following manner: The tube is preformed to a uniform shape. These open butted edge tubes are fed onto the machine one right after the other, and guaranteed to pass them automatically through the fixture closing up the gap between the several pieces automatically passing the pieces at a constant, steady speed and also close the butted edges tight together while passing under the welding head and off the water-cooled mandrel.

Tolerance of finished work depends entirely on the dimensions of the shell formed since the two edges of the seam are butted tightly together without changing the dimensions of the circumference.

For further information write to Victory Engineering & Machine Works, Inc., 3000 Chouteau, Saint Louis, Mo.

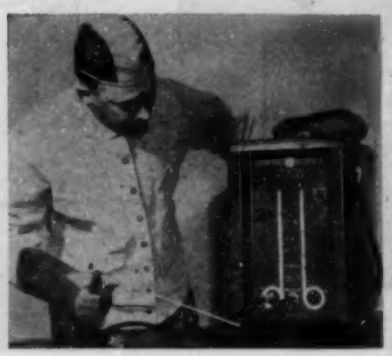
A.-C. FARM AND HOME ARC WELDER

A new a.-c. farm and home arc welder especially designed for operation on single-phase lines of limited capacity supplying rural areas and small communities has been announced by the General Electric Co. Conforming to N.E.M.A. Standards and Edison Electric Institute and Rural Electrification Administration requirements for farm welders, it is designed for the greatest possible protection for the operator and the equipment itself.

The new welder is furnished in two ratings, 130 and 180 amp., either with or without capacitors. Small in size and light in weight, it occupies little floor space and can be easily moved about. It has two plug-in connections for the electrode cable, one for use with $^{1}/_{16}$-in. or $^{5}/_{64}$-in. electrodes and one for $^{3}/_{32}$-in., $^{1}/_{8}$-in. and, in the larger rating, $^{5}/_{32}$-in. electrodes.

A welding current scale located on the front of the welder is calibrated in electrode sizes rather than in amperes. Current adjustments are made by means of a hand crank which provides an infinite number of settings to accommodate the size electrode being used. An electrode gage consisting of a series of calibrated notches on the bottom edge of the front panel makes possible quick identification of electrode size.

Designed into the new welder are several safety features which protect both the operator and equipment. The welder is constructed to use the lowest possible welding voltage consistent with good welding practice, and is enclosed in an electrically grounded metal case. In addition, it is protected against overload by a built-in circuit breaker.



Included with the welder are 15 ft. of electrode cable complete with plug connector and fully insulated electrode holder, 10 ft. of ground cable connected to the welder with ground clamp attached, 10 ft. of primary cable with a three-prong plug attached, and a wall receptacle.

Furnished in the accessory package is an instruction manual, a hand shield, slag hammer, scratch brush, pair of welder's gloves, Strike-Easy crayon, 4 lb. of Type W-25 all-purpose mild steel electrodes and 1 lb. of Type W-93 hard-surfacing electrodes.

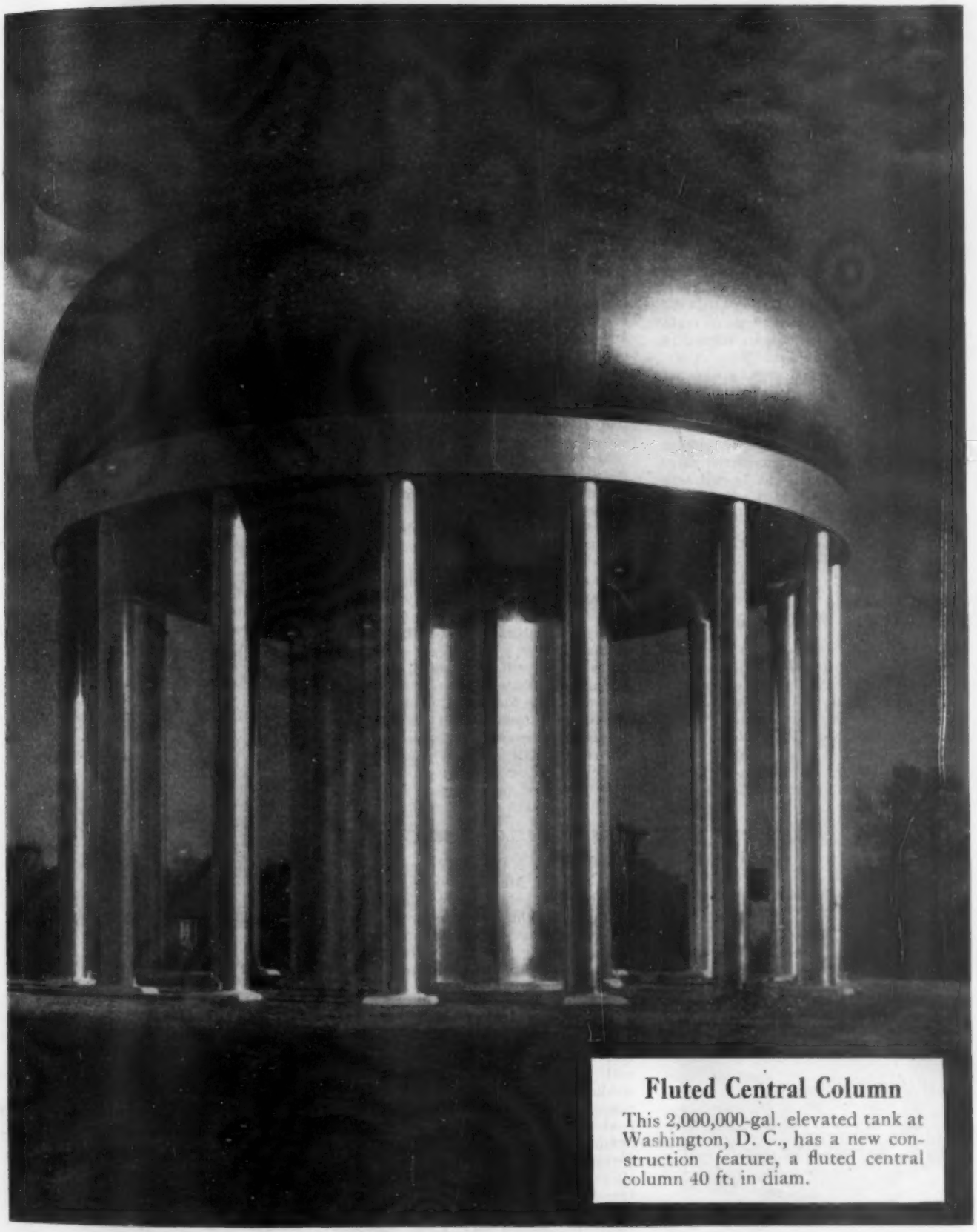
Additional information on the new welder is given in GEA 4630.

NEW MAGNETIC-FIELD GAGE

A new magnetic-field gage which indicates the relative strength of the magnetic field in parts which are being examined for flaws by the magnetic-particle method of testing has been announced by the General Electric Co. The new instrument is especially useful for testing large castings and forgings in which it is difficult to calculate the field intensity at various points from the current passed through the part and the cross-sectional areas.

In testing parts for flaws with the magnetic-particle method, a magnetic field is first set up in the part. Then magnetic particles are distributed over the surface of the part, and these line up along any crack or flaw. However, it is possible for a defect to be present even though not indicated by the magnetic particles if the magnetic field is not strong enough to bring out the particle pattern, and often identical flaws will appear as different sizes and thus give inconsistent results.

The new magnetic-field gage assures a magnetic field that is sufficiently strong to bring out the particle pattern, so that defects of the same size give similar indications. By giving a direct indication of



Fluted Central Column

This 2,000,000-gal. elevated tank at Washington, D. C., has a new construction feature, a fluted central column 40 ft. in diam.

CHICAGO BRIDGE & IRON COMPANY

Chicago 4.....2455 McCormick Bldg.
New York 6.....3398—165 Broadway Bldg.
Cleveland 15.....2282 Guildhall Bldg.
Detroit 26.....1556 Lafayette Bldg.
Birmingham 1.....1907 North 50th Street
Tulsa 3.....1654 Hunt Bldg.
Atlanta 3.....2186 Healey Bldg.
Houston 1.....5624 Clinton Drive
Washington 4.....703 Atlantic Bldg.
Philadelphia 3.....1668-1700 Walnut Street
Los Angeles 14.....1471 Wm. Fox Bldg.
San Francisco 11.1297-22 Battery Street Bldg.

Fabricating plants in CHICAGO, BIRMINGHAM; and GREENVILLE, PA.

field strength, it permits standardized testing at fixed field intensities.

The new instrument measures both alternating-current and direct-current field strength. Small and portable, it can be used wherever 115-volt, 60-cycle power is available. The instrument consists of a gage head which is permanently attached to a field strength indicating unit. The head consists of small coils wound around a U-shaped laminated metal core mounted in a plastic handle. Pole shoes are attached to the ends of the core, and these make contact with the piece being tested.

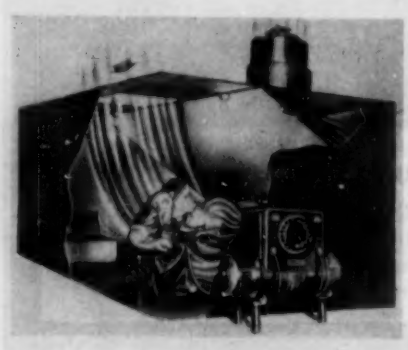
On the front of the indicating unit are mounted an indicating instrument with two scales, two selector switches for alternating or direct current, and an "On-Off" switch. The instrument scale is calibrated in field units which are related to the magnetic-field strength.

In operation, the pole shoes are placed in contact with the test surface. Direct or alternating current is then applied to the part in accordance with the regular magnetic-particle method. The current is increased or decreased until the magnetic-field gage indicates the desired field units for the particular test. The magnetic particles are then applied in the specified way.

PRODUCTION WELDING BOOTH

To protect their health and provide more pleasant working conditions for production welders is the purpose of this new fresh air, safety welding booth being planned for future production by The Hobart Brothers Co., Troy, Ohio.

The booth will be $9\frac{1}{2}$ ft. wide, $9\frac{1}{4}$ ft. deep and 7 ft. high. It is to be constructed of fabricated panels of 16-gage sheet steel formed with companion flanges, punched on 12-in. center for bolting assembly. This type construction makes it easy to disassemble the unit to move to another location if desired. The door is sliding type with overhead track and easy running rollers, and measures 43 in. wide by 78 in. high.



The heavy-duty exhaust fan draws in the fresh, cool air through an opening in the top, down past the operator to pick up welding fumes and heat, and then expels it to the outside of the building. In this manner, this booth serves a double purpose in providing fresh air and comfort to the welding operator, and at the same time protects fellow workers in other parts of the plant from eyeburn and welding fumes.

THERMOCOUPLE

A new portable thermocouple for measuring molten aluminum temperatures and regarded as suitable for measuring lead, babbitt, zinc, type metal and similar low-melting temperatures, has been developed and will be introduced soon by the Brown Instrument Co., Philadelphia.

"Metal temperatures," according to L. Morton Morley, vice-president and general sales manager of the Brown company, industrial division of Minneapolis-Honeywell Regulator Co., "can be measured below the surface of the bath in a matter of seconds, while the readings are unaffected by couple wire conditions and parasitic current generation is wholly absent at the hot junction, situations that occurred formerly."

Mr. Morley pointed out the new thermocouple has been successfully field tested by two of the largest foundries in the country.

In operation, it was explained, the couple is immersed several inches below the surface of the bath and held there until a steady reading is obtained on the measuring instrument, usually 10 to 12 sec. The couple is then withdrawn, adhering metal being removed by shaking the handle.

The couple will be supplied, if desired, as part of a complete system comprising a circular chart ElectroniK potentiometer, an external standardizing accessory for specific requirements, and spare tips and extension leads.

PHOSPHIDE ALLOY BRAZING ALLOYS

MACOLOY is the trade name given to the series of McCauley patented nonferrous phosphide brazing alloys which melt at low to high temperatures. These phosphide alloys incorporate unique corrosion-resistant properties, including resistance to solutions of sulphuric, hydrochloric and many other acids.

These brazing alloys have a copper base and are used for the corrosion-resistant coating, brazing and joining of ferrous, nonferrous, alloys and dissimilar metals with the gas, metallic and carbon arc welding methods in production and maintenance. While self-fluxing for numerous applications, the use of a suitable brazing flux will facilitate the brazing operation. These phosphide brazing alloys are available in three different brand types: MACOLOY "E," fluid at 1150° F.; MACOLOY "F," fluid at 1180° F., general and special purpose; MACOLOY "G," fluid at 1600 to 1900° F., as specified.

MACOLOY "F" is a copper, tin, antimony, phosphorous alloy which has a general as well as a particular purpose in brazing applications at low temperature. "F" is especially adapted to coating, brazing and joining of a wide range of metals and alloys, including ferrous and nonferrous applications, such as cast iron, steel, stainless steel, brass, bronze, copper, Monel, nickel and other alloys. It also has the exceptional characteristic of being suitable for joining many kinds of dissimilar metals. It incorporates unique corrosion-resistant properties, including resistance to solutions of sulphuric, hydrochloric and many other acids. Further, this alloy is exceptional because of its excellent electrical and thermal conductivity, tensile strength, good tinning and wetting qualities, capillary attraction, color match, etc. It can be used in the various brazing operations at a great savings in cost and economy in production and maintenance.

Inquiries for special developments will receive immediate attention. Information regarding MACOLOY phosphide brazing and welding alloys as well as MACO phosphide alloy castings and other MACO products can be obtained by writing to McCauley Alloy Sales Co., 407 S. Dearborn St., Chicago 5, Ill.

SELF PROPELLED RAIL TYPE WELDER

To be available soon are the new models of Hobart Self-Propelled Railway Welders in 300- and 400-amp. sizes.

This distinctive outfit is specially designed for all railway welding, particularly along the right of way, where it moves under its own power from place to place and is easily derailed to clear the tracks if necessary.

A gasoline engine drives the arc-welding generator, from which power may also be taken to operate the heavy-duty electric motor that drives the rear wheels. Speed

can be varied from practically nothing up to approximately 20 miles per hour. Power is sufficient to tow a work car with 8 or 10 men aboard.

The wheels of the unit are insulated, flanged, railway type with solid steel axle in front and standard automobile type rear axle. Wheels are standard railway track gage.

Electrical controller for driving the car forward or in reverse is conveniently located for hand operation. The throttle control and hydraulic brake pedal are conveniently located for foot operation. A comfortable operator's seat has large compartment for tools, and door becomes a handy welding or work bench when opened.

NEW ELECTRODE

A 16-page bulletin describing a new type of electrode designed to prevent underbead cracking in the welding of

"difficult-to-weld" steels is announced by Metal & Thermit Corp., 120 Broadway, New York 5, N. Y. The bulletin gives complete information on Type HTS, a lime-ferritic electrode which will weld successfully such materials as the high sulphur-free machining steels used in mold and die work, high-carbon steels, cold-rolled steels and cast iron. In addition to general descriptive matter, tables giving full data on the physical properties and chemical analysis of the Type HTS deposit in all standard electrode sizes are included, as well as information covering the effect of stress relieving and the comparative deposition characteristics of Type HTS and other mild steel electrodes such as A.W.S. Grades E-6010 and E-6020. Various actual applications are also discussed, along with the advantages which have accrued from the use of this type of electrode.

ASBESTOS GLOVES AND MITTENS

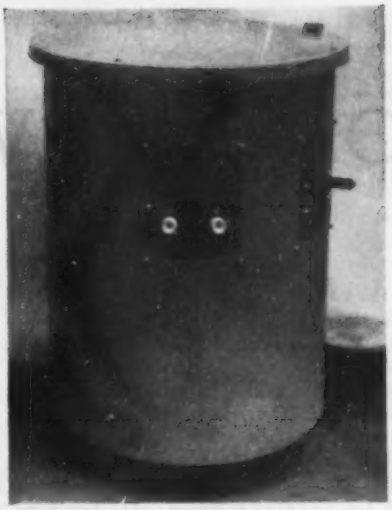
A new line of Asbestos Gloves and Mittens, known as GARDWELL, feature a specially designed thumb arrangement on the leather reinforced styles, whereby

the leather reinforcement completely covers the thumb at points of hardest wear, thereby greatly strengthening the thumb of both glove and mitten. This specially designed reinforcement on the thumb helps prevent thumb seam from ripping open and greatly prolongs the life of both glove and mitten.

GARDWELL Underwriters Grade Asbestos Gloves and Mittens with leather reinforced palm and thumb; or palm, fingers and thumb are suitable for heavy-duty work, especially in handling hot metal with sharp edges. All styles are available in any lengths, the 11-, 14- and 23-length gloves and mittens being more popular, and are furnished with or without lining. All seams are double sewn. Made by Safety Clothing and Equipment Co., 7016 Euclid Ave., Cleveland 3, Ohio.

NEW 20-KVA. MOBILE BRAZER

Designed for general brazing service, a new 20-kva. portable brazer with water-cooled tongs is announced by the Westinghouse Electric Corp.



Enclosed in a circular steel housing, the entire unit is self-contained, having a contactor for energizing or de-energizing the brazing circuit, an adjustable heat brazing transformer and a water-cooling system for the tong cooling water. Diameter is kept small (24 in.) so that it can be lowered through hatches, watertight doors and manholes. A clamp-type entrance bushing is provided on the rear of the brazer for the incoming primary cable. The unit requires only connection to a 220- or 440-volt power source.

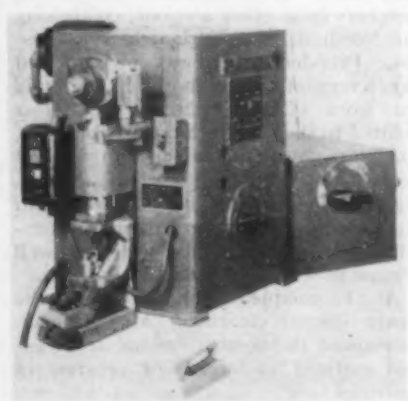
The control panel, built into the front of the brazer, contains a control switch, outlets for brazing cables, receptacle for foot switch pilot cable and voltage tap changing plug. The foot switch, which controls the length of time during which current is applied, is provided with a length of pilot cable so that it may be placed at the operating station.

The brazing transformer is air cooled by induced draft. Air is drawn into the brazer through openings under the top cover, is pulled through the transformer and expelled through screened openings in the bottom of the brazer case.

Further information on the new 20-kva. brazer may be secured from the Westinghouse Electric Corp., Box 868, Pittsburgh 30, Pa.

15-KVA. MOTOR DRIVEN BENCH-TYPE SPOT WELDER

This bench-type spot welder recently developed by Thomson Electric Welder



Co. of Lynn, Mass., is designed to provide a compact, accurately built machine suitable for rapid resistance welding of small parts. Welders of this type are generally used for assembling small parts which are handled quite rapidly so that compactness is highly desirable in order to provide as much bench space as possible on either side of the welder for piling up unfinished and finished work. Much of this work is performed by women operators, usually unskilled, and simplicity of adjustment and operation are important factors.

The Model A-11 bench-type spot welder shown is driven by a $^1/_4$-hp. motor geared to a worm reduction unit which turns a cam shaft through a one-revolution clutch. Operation is initiated through a solenoid clutch pull controlled by a foot push-button switch. With this arrangement the operator can either trip the clutch once to put the machine through a single welding cycle or, by steady pressure on the switch, keep the machine running constantly.

Two transformer capacities are available—10 and 15 kva. Current control is obtained by a multileaf fan-type cam mounted on the cam shaft.

DR. E. C. BAIN HONORED

The American Society for Metals recently announced that Dr. Edgar C. Bain has been awarded the Albert Sauveur Achievement Award for 1946. Dr. Bain is vice-president in charge of metallurgy and research of the Carnegie-Illinois Steel Corp., Pittsburgh, Pa.

This year's award was made on the basis of the recipient's conception of a new approach to the heat treatment of steel. The citation states that "prior to the work of Bain, relatively little was known about the mechanism of the hardening of steel. True, people had known from earliest times that steel, having been heated to an elevated temperature, would become soft if cooled slowly and would be hard if cooled rapidly. When the microscope was applied to steel, it was learned that the soft material was characterized by a microscopic structure called pearlite while the structure of the hard material was called martensite. But as to precisely how and exactly when these structures formed, very little was known."

"Dr. Bain conceived the idea that the mechanism of heat treatment might become known if each step in the cooling was investigated, examining the product formed at each temperature level during cooling. This concept was not so simple as it may seem, for it involved the additional realization, until then unknown, that at each temperature level the transformation occupied time and that the product could therefore be studied as it formed. . . . ."

Dr. Bain's work on heat treatment of steel was begun approximately 15 years ago.

Award of the scroll and plaque will be made on November 21st at the American Society for Metals' annual banquet, held as part of the National Metal Congress and Exposition at Atlantic City, N. J.

SECTION ACTIVITIES

BOSTON

The following Committee Chairmen have been appointed to serve for the current Section year: Meetings and Papers Committee—George A. Ross, General Electric Co., West Lynn, Mass. New and Delinquent Members Committee—H. Hugo Stahl, Lincoln Electric Co., Boston, Mass.

CHICAGO

The following officers have been elected to serve for the 1946–47 season ending next June.

Chairman, Harris A. Goodwin II, The Bastian Blessing Co.; *1st Vice-Chairman*, Charles A. Druetzler, Electro-Motive Division, General Motors Corp.; *2nd Vice-Chairman*, Charles W. Steele, National Cylinder Gas Co.; *Secretary-Treasurer*, Ted B. Jefferson, Editor, *The Welding Engineer*. *Directors:* (three years). Irving H. Carlson, S. S. Callner, Ted Russell and E. J. Burrowes; (one year) W. C. Pearson.

CINCINNATI

The final meeting of the 1945–46 season of the Cincinnati Section was held on Tuesday, June 25th, at the Engineer's Club. No technical paper was presented at this meeting and the evening was devoted to the election of officers for the 1946–47 season, and to a general discussion of ways and means of increasing the activities of the Section.

The following officers were elected.

Chairman, Larry E. Sherman; *1st Vice-Chairman*, William F. Pahner; *2nd Vice-Chairman*, J. Nelson Black; *Secretary-Treasurer*, Robert F. Martin.

In addition to the above, the following were elected for a two-year term on the Executive Committee: Fred D. Turrill, William A. Maddox and John Kelley.

The next meeting of the Section will be held in September, at which time a plant visitation will be made to the Trailmobile Co.

DAYTON

Annual Stag Dinner was held at McCrabb's Grove on Wednesday, June 19th. Activities started at 4:00 P.M.; dinner at 7:00 P.M. Indoor sports were enjoyed after dinner. Refreshments were served. Ball games and horse shoes were enjoyed in the afternoon.

LOS ANGELES

Last meeting of the season was held June 20th, at Scully's Cafe. The first speaker of the evening was Tom Hazlett of Lockheed Aircraft Co., whose work on aircraft weld test methods is well known throughout the country.

Art Casebeer, Quality Engineer for Bates & Boswell Co., gave considerable new information on the application of statistical control.

The following officers have been elected.

Chairman, David Bisbee, Norris Stamping Co.; *Vice-Chairman*, Al Fenlason, Consolidated Steel Corp.; *Secretary-Treas.*, E. O. Williams, Victor Equipment Co. *Executive Committee:* Charles B. Smith, Herm Hoth, and Hugo Hiemeke.

The next meeting will be held on September 19th.

LOUISVILLE

The annual business meeting of this Section was held on June 25th, at which time the results of the election were announced as follows:

Chairman, G. W. Plinke; *Vice-Chairman*, E. H. Dilley; *Treasurer*, Murray Davis; *Secretary*, R. E. Morrison. *Directors:* H. C. Wallace, C. E. Schiller and J. W. Hebden. The success of the past year's program was discussed and new ideas for the coming year were brought up. It was decided that the Welding Conference that was held at the University of Louisville was such a success it would be continued next year and expanded.

MILWAUKEE

Newly appointed officers of the Milwaukee Section are as follows:

Chairman, J. B. Welch, Cutler Hammer Corp.; *Vice-Chairman*, H. E. Bailey, Nordberg Corp.; *Secretary-Treasurer*, C. C. Hart, Heil Co. *Directors:* M. W. Hippe, G. Leupold, R. P. Walbridge and M. O. Monsler.

NORTHERN NEW YORK

Thirty-two members attended the annual dinner, which was held in Albany on May 22nd. A considerable number of members from other sections, comprising the Northern New York area, were present. President Hess was present and gave a very interesting short talk, outlining the work of the SOCIETY. Dr. Hess pointed to the forty technical committees, which are now active in the SOCIETY, and promised still further technical activity. Dr. Hess pointed out that THE WELDING JOURNAL has made a very significant contribution in keeping the members well abreast of welding developments.

At the completion of the dinner, the newly elected chairman, Mr. Garman, announced the committees for next year and outlined an interesting program of activities.

Following the dinner, the colored motion picture, "This Is Resistance Welding," was shown and obtained a very favorable reaction from the members present.

Newly elected officers for the 1946–47 season are as follows.

Chairman, G. W. Garman, General Electric Co.; *Vice-Chairman*, E. N. Boswell, American Locomotive Co.; *Secretary-Treasurer*, C. M. Rhoades, Jr., General Electric Co.; *Program Chairman*, E. N. Boswell; *Membership Chairman*, W. J. Campbell, General Electric Co. *Executive Committee:* H. O. Westerndarp, H. L. Palmer, R. A. Gilbert, H. S. Swan, J. B. Nolan and M. F. Sayre.

PASCAGOULA

The Pascagoula, Miss., Section enjoyed their annual get-together meeting on June 26th with a buffet dinner served at the Pascagoula Country Club. A few invited guests were present.

The June meeting is an annual social feature in appreciation of the services of the outgoing officers, and to welcome the newly elected officers.

The nominating committee announced the unanimous election of the following officers for the new fiscal year.

Chairman, Dow Ripley; *Vice-Chairman*, Phil Ware; *Secretary-Treasurer*, L. G. Weber. Members-at-large: R. H. Macy and C. H. Faulkenberry. Members of the Board: E. H. Holder, Johnny Furr, Tom Dawson and Sidney Swan, District Vice-Pres.

The officers and program committee were congratulated on their excellent services in having an average meeting attendance for the year of seventy-six members and guests. Plans for the coming year were discussed.

SAINT LOUIS

The St. Louis Section formally closed its 1945–46 season with its annual dinner meeting in the Ballroom of Hotel De Soto on June 28th. Approximately 235 members and guests were present.

R. Forder Buckley, a prominent St. Louis Attorney and well-known humorist, served as Master of Ceremonies and principal speaker. In the former role, he introduced the following officers and directors who were elected in the June election.

Chairman, Gayden Derickson, Shell Oil Co. Inc.; *Vice-Chairman*, Howard Close, Machinery & Welder Corp.; *Treasurer*, I. T. Olson, The Linde Air Products Co.; *Secretary*, A. Pandjiris, Pandjiris Welding Engrg. Co. *Directors:* C. H. Armstrong, Phil Becker, F. R.

Garner, H. Weigel and R. K. MacIntyre.

As principal speaker, Mr. Buckley talked in a serious tone on the "American Way of Life" in such a manner as to hold the complete attention and to provoke the thinking of all persons present. Mr. Buckley's talk was enthusiastically received.

SOUTH TEXAS

Election ballots for new officers were counted at the June 27th meeting held at Y.M.C.A. in Houston. A motion picture on travels in India was enjoyed by all. The new officers then took over and led a discussion on what the Section needs for the coming year.

New officers for 1946–47 are as follows:

Chairman, T. J. Kegg, Champion Rivet & Supply Co.; *Vice-Chairman*, Steve Demecs, Westinghouse Electric Corp.; *Secretary-Treasurer*, W. H. Greer. *Directors for Two Years:* A. E. Wisler, Ed Bruckmiller, S. C. Hamilton, Roy Brunt, Frank Neal, Jr., and E. B. Thompson.

TIDEWATER

The Tidewater Section held its annual meeting on Tuesday, June 11th, in the Fleet Reserve Hall, Portsmouth,, Va. New officers were elected as follows:

Chairman, A. C. Bergh, Naval Shipyard; *Vice-Chairman*, P. C. Greene, Naval Shipyard; *Secretary-Treasurer*, H. R. Floyd, Naval Shipyard. *Directors for Two Years:* E. S. Nance, E. T. Willey, C. F. Grubbs and M. Friedmann.

List of New Members

June 1 to June 30, 1946

CANADA

Wells, C. M. (B), Curtis Wells, 370 Victoria St., Toronto 2, Ontario, Canada.

CHICAGO

Glines, Robert W. (C), 1619 Davis Ave., Whiting, Ind.
Hoffman, Henry L. (C), 3930 W. Jackson Blvd., Chicago 24, Ill.
Hutman, Donald D. (C), Albert Pick & Co., 2159 Pershing Rd., Chicago, Ill.
McGuan, John P. (B), 7507 S. Carpenter St., Chicago 20, Ill.
Miller, H. K. (C), Hobart Welder Sales & Service, 542 W. Washington Blvd., Chicago 6, Ill.
Simms, Thomas S. (C), 6604 W. Roosevelt Rd., Oak Park, Ill.
Smith, Kenneth E. (B), 1408 N. Waller St., Chicago, Ill.

COLUMBUS

Groeniger, Edward (C), P. O. Box 444, Marion, Ohio.

DETROIT

Bernhardt, Lowell (F), 13225 Lauder, Detroit 27, Mich.
Eastberg, Albert M. (B), Harnischfeger Corp., 845 Book Bldg., Detroit, Mich.
Saunders, Frank B. (B), Harnischfeger Corp., 845 Book Bldg., Detroit, Mich.

INDIANA

Heffernon, Culver A. (C), 3730 Caroline Ave., Indianapolis, Ind.

INLAND EMPIRE

Blackford, L. J. (B), W. 2028 Riverside, Spokane, Wash.
Fait, Fred (B), N. 6228 Whitehouse, Spokane 12, Wash.
Finch, Vernon B. (B), 1303 So. Fiske, Spokane, Wash.
Forsyth, Macy (C), 814 E. 32nd Ave., Spokane Wash.
Gravos, Albert H. (B), 303 W. Montgomery, Spokane 11, Wash.
Harris, Clark E. (B), E. 1719 Wabash, Spokane 14, Wash.
Haskins, Roy (B), E. 1904 Boone, Spokane, Wash.
Johnson, Rowland D. (B), E. 1622 Central Ave., Spokane 14, Wash.
Jordan, A. W. (B), S. 115 Monroe St., Spokane, Wash.
Kile, Lennis A. (B), N. 2508 Perry, Spokane, Wash.
King, John W. (C), E. 118 Garland Ave., Spokane 13, Wash.
Kross, Walter F. (B), 3712 Ella St., Route 5, Spokane, Wash.
Kulp, Harold S. (C), Marlin Consolidated Schools, Marlin, Wash.
Long, Adrian L. (B), N. 3922 Napa St., Spokane 14, Wash.
Pentz, Walter F. (B), W. 2209 Providence, Spokane, Wash.
Reynolds, E. L. (B), Spokane Blacksmith & Welding Wks., 1502 E. Trent, Spokane 15, Wash.
Richardson, Chester A. (B), 604 W. Augusta, Spokane 12, Wash.
Rogers, D. W. (B), Broadway Welding & Machine Wks., W. 1021 Broadway Ave., Spokane, Wash.
Schimmels, Harold (B), Route 2, Opportunity, Wash.
Scott, S. J. (B), 1501 E. Trent Ave., Spokane, Wash.
Sholes, Thomas S. (B), N. 5615 Monroe, Spokane 12, Wash.
Vaughan, George E. (B), c/o Mac's Trailer Camp, Route 7, Spokane, Wash.
Warrior, Clyde (B), 434 W. Buckeye, Spokane 12, Wash.
Weishaar, Jacob J. (B), Weishaar's Welding, W. 8 Sprague Ave., Spokane 8, Wash.

LOS ANGELES

Bohling, John E. (C), Weld-craft, 206 W. 8th St., National City, Calif.
Hazlett, Thomas H. (C), 4550 Bakman Ave., North Hollywood, Calif.
Koop, Ernest J. (B), P. O. Box 1422, Shafter, Calif.
Malee, H. J. (C), Land Mach. Wks., 969 E. Second, Pomona, Calif.
West, Leo M. (C), 5842 Clark, Bellflower, Calif.

MARYLAND

Braun, Walter H. (C), Eastern Stainless Steel Corp., Baltimore 3, Md.

MILWAUKEE

Ballman, Bruce P. (C), Harnischfeger Corp., 4400 West National Ave., Milwaukee 14, Wis.
Everitt, E. S. (C), 4130 W. Martin Dr., Milwaukee, Wis.
Hart, William T. (C), 1331 N. 39th St., Milwaukee, Wis.
Siebauer, Lucian M. (C), National Cylinder Gas Co., 606 W. Wisconsin Ave., Milwaukee 3, Wis.
Souter, Vincent W. (C), National Cylinder Gas Co., 606 W. Wisconsin Ave., Milwaukee, Wis.
Wollering, Walter R. (B), 2858 So. Ellen St., Milwaukee 7, Wis.
Zahn, Otto C. (C), 4073 So. Lake Dr., Cudahy, Wis.

NEW JERSEY

Avery, Howard S. (B), P. O. Box 251, Mahwah, N. J.

NEW YORK

Robbins, John T. (B), Peter A. Frasse & Co., Inc., 17 Grand St., New York 13, N. Y.

OKLAHOMA CITY

Cates, H. A. (C), c/o Black Sivalls & Bryson, Inc., Box 1714, Oklahoma City, Okla.

PASCAGOULA

Moore, Vincent (C), 422 Lake Ave., Pascagoula, Miss.

ST. LOUIS

Schumacher, Emil F. (C), 3659 Bellerive Blvd., St. Louis 15, Mo.

SOUTH TEXAS

Davis, Elmer H. (C), General Elec. Welding Div., 5931 Clinton Dr., Houston, Tex.
Gurklis, Peter J. (C), 1422 W. Broad St., Freeport, Tex.
Kegg, Thomas J. (B), Champion Welding Rivet & Supply Co., 447 Esperson Bldg., Houston 2, Tex.
Simpson, Willard E. (B), 1446 Milam Bldg., San Antonio 5, Tex.

Whetstone, H. R. (B), Metal Welding & Maint. Co., 4208–10 Griggs Rd., Houston 4, Tex.

TACOMA

Bond, W. T. (B), Bond Welding Co., 1013 East E. St., Tacoma, Wash.
Netzel, J. E. (C), Rt. 7, Box 536, Tacoma, Wash.
Peterson, Wellington J. (B), Peterson Welding Service, 151–13th St. W., Milton, Wash.

TOLEDO

Busick, Adrien F., Jr. (B), 617 W. Center St., Marion, Ohio.
Marion, William H. (C), 320 Ontario St., Toledo, Ohio.

WESTERN NEW YORK

Hoagland, Richard (B), 399 Huxley Dr., Snyder, Buffalo, N. Y.
Steinert, Emil F. (C), Westinghouse Elec. Corp., Box 2025, Buffalo 5, N. Y.

NOT IN SECTIONS

Antere, Bertel (C), Konepaja, Warkaus, Finland.
Eddy, Maurice H. (B), Rt. 8, Box 460, Lakewood 15, Colo.
Leroy, Mr. A. (C), c/o Institut de Soudure Autogene, 32 Blvd. de la Chapelle, Paris, France.
McCoy, Clifford T. (B), Hotel America, Barcelona, Venezuela, S. A.
McGuire, R. V. (B), 3738 Morrison Road, Denver 9, Colo.
Miner, W. K. (C), Denver Tramway Corp. 1100–14th St., Denver 2, Colo.
Rincon, Federico (C), C. A. La Comercial Prosperi, Edificio San Pablo, Mercaderes a Municipal, Caracas, Venezuela, S. A.
Seese, Austin H. (B), National Cylinder Gas Co., 1400 N. Fares Ave., Box 784, Evansville, Ind.
Smick, Adam W. (B), 1301–25 Market St., Denver, Colo.
Swift, C. Brinton (B), T e Linde Air Prods. Co., 2101 Blake St., Denver 2, Colo.

Members Reclassified

During Month of June

DETROIT

Strehler, Chas. (from C to B), Weldit Acetylene Co., 638 Bagley Ave., Detroit, Mich.

INLAND EMPIRE

Douglas, G. C. (from C to B), W. 3305 Alice Ave., Spokane 12, Wash.

ABSTRACTS OF CURRENT WELDING PATENTS

Prepared by V. L. Oldham

Printed copies of patents may be obtained for 25¢ from the Commissioner of Patents, Washington 25, D. C.

2,400,006—Process of Bonding Metal—Antonio Longoria, South Euclid, and Christian Girl, Madison, Ohio, inventors; assignors, by direct and mesne assignments, of one-half to said Antonio Longoria and one-half to Unit Rays, Inc. (2 Claims)

The bonding process relates to a method of securing a ring of cobalt alloyed with chromium and tungsten to the frusto-conical peripheral portion of a valve head. In the process, a metal from the group of chromium and nickel and having a melting point approximately equal to that of the peripheral portion of the valve head but higher than that of the cobalt alloy is first electrically deposited on the head, after which the cobalt alloy is placed around the periphery of the valve head and it and the peripheral portion only of the head are heated to bond the alloy to the head.

2,400,889—Welding Apparatus—Joseph U. Ridder, inventor, Lakewood, Ohio, assignor to The Yoder Co. (9 Claims)

Ridder's apparatus is for welding a seam in preformed tubing by use of rotatable electrodes. It has a holder fixedly mounted in the tubing in advance of the electrodes, a device which is fulcrumed on the holder forms a plurality of guide portions for engaging with the inner surface of the tubing, and a spring is provided to urge the device, under pressure, against the inner wall of the tubing.

2,400,903—Welding Tool—Edward J. Allen, inventor, Cleveland, Ohio, assignor to The Leece-Neville Co. (4 Claims)

The tool has a handle and a hollow head with the head having a chamber therein for receipt of cooling medium and a hollow rod support extending through the chamber. Movable clamping means for the welding rod are provided and they have an actuating member adjacent the handle so as to be controlled by the same hand that holds the tool.

2,400,921—Welding Method—William G. Dow, Harold C. Early, and Henry J. Gomberg, inventors, Ann Arbor, Mich., assignors to General Motors Corp. (9 Claims)

This welding method is for securing a plurality of electro-conductive members together where thin spacer means formed at least partially of insulating material are placed between the members to define an area. Electro-conductive means are provided between the members in the defined area to give intimate electrical contact at one point, and high frequency electrical power is applied to the members at a sufficiently low voltage to avoid arcing there between.

2,400,992–Remote Control for Welding Apparatus—Edward S. Hebeler, inventor, Williamsville, N. Y., assignor by mesne assignments, of one-half to Unit Rays, Inc. (13 Claims)

The control relates to arc welding apparatus for use with a metallic electrode and a variable resistance is provided in the welding circuit, which resistance is cut in or removed from the circuit by electrically controlled means.

2,400,993—Welder's Mask or Helmet—Edward S. Hebeler, inventor, Williamsville, N. Y., assignor of one-half to Unit Rays, Inc. (11 Claims)

This welder's mask has an opening in it with a glare-proof shield reciprocably mounted behind the window. Chin-operated means are associated with the means positioning the shield to control same.

2,401,359—Butt Welding Machine—Oscar G. Lilja, inventor, Rockford, Ill. (20 Claims).

Lilja's machine has two horizontal electrode arms that are movable toward each other with the lower arm having a device carried thereby for seating two work pieces in abutting relationship and the upper arm carrying a clamp to engage with the device and work pieces as the arms move together. Means for shifting one of the work pieces toward the other are also provided and are operated by the movement of the arms toward each other.

2,401,383—Electrode Holder—Wayne E. Wilson, inventor, Schenectady, N. Y., assignor to General Electric Co. (13 Claims).

The holder patented is for use in arc welding and it has an electrode holding jaw member received in a hollow cap that is rotatably carried by the holder. A contact rod is fixedly received in the holder and has an end that cooperates with the jaw to position an electrode.

2,401,523—Welding Electrode Holder—Raymond L. Townsend, inventor, Wichita, Kan. (4 Claims)

Townsend's holder has two relatively movable jaws normally urged into engagement by a spring member. The holder's

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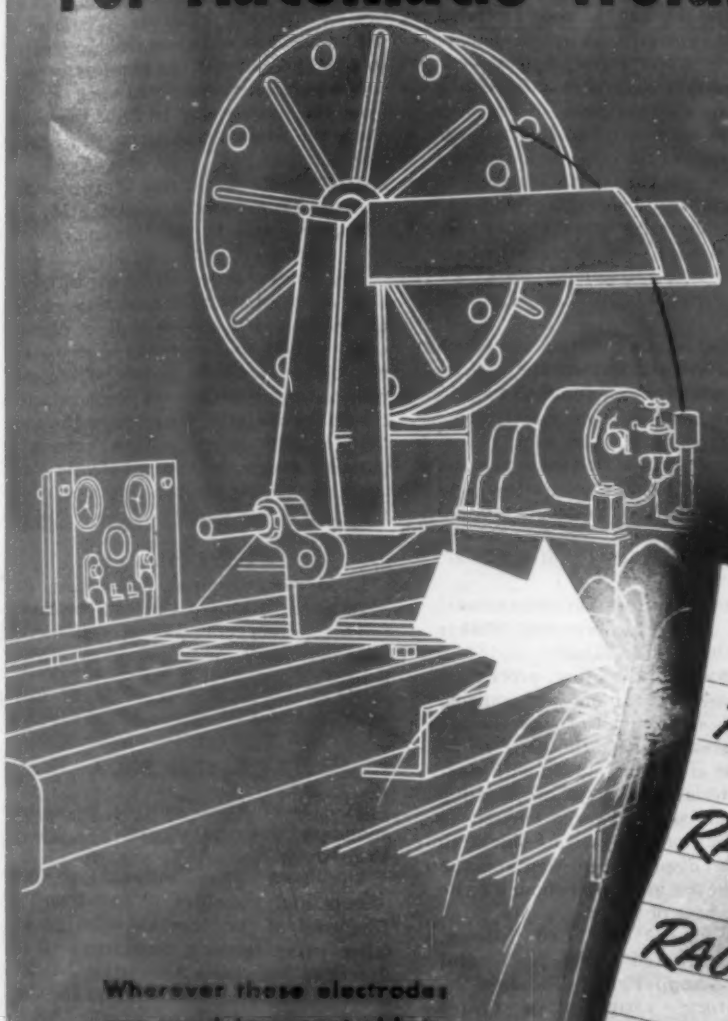

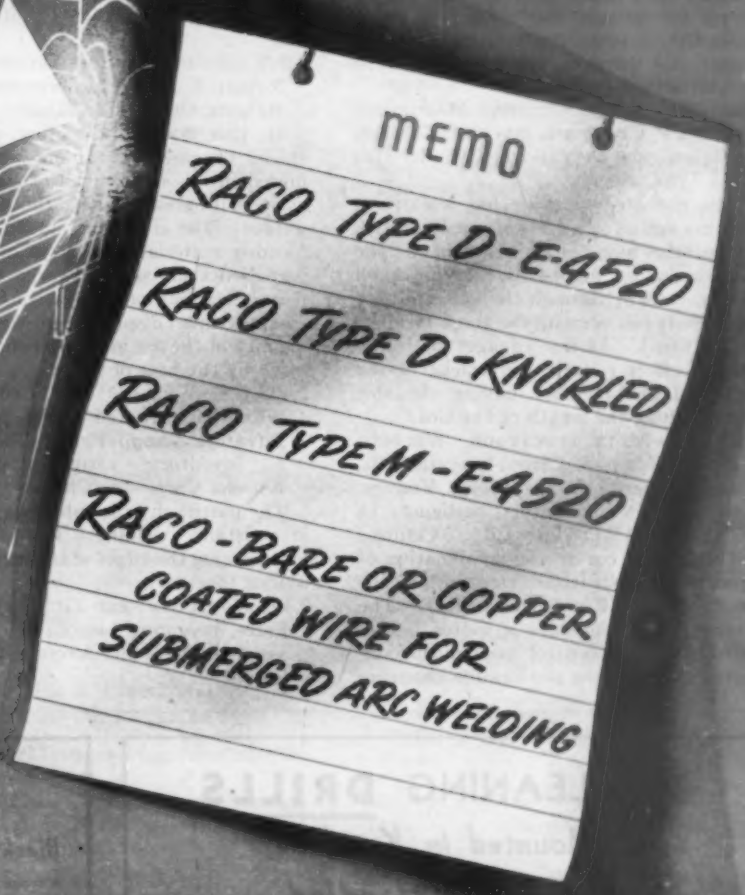

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novelty includes a replaceable insulation cover for the holder.

2,401,528—Resistance Welding—Alfred Vang, inventor, New York, N. Y., assignor, by direct and mesne assignments, to Continental Can Co., Inc. (4 Claims)

This welding apparatus includes two opposed electrodes connected to the secondary of a transformer and movable toward each other. Magnetic means, including a coil, are provided to move the electrodes toward each other and such coil, a condenser, and a mercury vapor discharge tube are connected in series with the primary of the transformer.

2,401,655—Pin Welding Gun—George Vinson Moore, inventor, Campton, Calif. (4 Claims)

Moore's gun includes a case, a cushioned contact supported at one end of the case for engagement with the positive lead of a welding circuit, a pin-engaging clutch supported at the other end of the case, a plunger in the case electrically connected to the clutch, and a contact movable with the plunger into and out of engagement with the first contact. The case also has means for moving the plunger so as to bring the contacts together to complete a circuit and then releasing the plunger to break the circuit.

2,401,721—Torch Cutting Machine—Alfred F. Chouinard, inventor, Chicago, Ill., assignor to National Cylinder Gas Co. (9 Claims)

The patented machine has a carriage member and a torch carrying member with one member having a hole therein and the other a slot. A pivot bolt, carrying a coil spring, extends through the hole and slot and resists but permits the torch member to be tilted. Means engages with the bolt to effect relative movement of the bolt and the member having the slot therein along the length of the slot.

2,401,722—Multi-electrode Welding Head—Edwin A. Clapp, Niagara Falls, and Leonard V. Spangberg, Youngstown, N. Y., inventors; assignors to The Linde Air Products Co. (5 Claims.)

This patent covers the combination of a pair of electrode feed devices with means for driving both of such devices. The driving means includes a motor and a differential feed control mechanism connected between the devices for changing the relative rates at which the devices are driven by the motor.

2,402,004—Portable Spot Welder—Robert Earl Adams, inventor, Vancouver, Wash., assignor to George H. Buckler. (4 Claims)

Adams' welder has a lower member with a pistol type grip, an upper member hinged to the lower member near their rear portions, and electrodes and welding tips carried by the members. A trigger is pivoted on the lower member and has a rear arm lying adjacent the grip portion while a forward portion of the trigger connects to the upper member. A spring is provided to retain the welding tips apart.

2,402,031—Method of Welding—Paul Ffield, inventor, Hingham, Mass., assignor to Bethlehem Steel Co. (4 Claims)

This method relates to articles on which overlays are welded wherein the articles contain up to 0.1 carbon, about 11 to 15% chromium and the balance mainly iron. The method comprises the steps of determining the expansion that takes place on cooling after a welding operation, and welding the overlays on the chromium steel whose expansion on cooling after the overlay welding operation is above 1300° F.

2,402,165—Process of Arc Welding—Robert E. Kinkead, inventor, Shaker Heights, Ohio. (18 Claims)

In this novel arc-welding process, a shield of gases containing arc ionizing ingredients is maintained around the arc as it is progressed along the piece to be welded. The arc is surrounded with slag-forming materials free from arc ionizing ingredients in particles large enough to permit the gas of the gaseous shield to escape without displacing the slag from the vicinity of the arc and small enough to be fused by the heat of the arc.

2,402,178—Welding Jig—Leif Nilssen, Westerleigh, Staten Island, N. Y., and Salvatore Joseph Finelli, Rahway, N. J., inventors; assignors to Foster Wheeler Corp. (12 Claims)

The patented jig is tubular and for use in resistance welding. It has contacts for engaging the edges of the articles to be welded together.

2,402,275—Pokeweld Gun—Donald H. Estes, inventor, Lincoln Acres, Calif., assignor to Rohr Aircraft Corp. (1 Claim)

This pokeweld gun has a barrel-shaped electrode with an elongated passageway in it which has inlet and outlet ports provided therefor. A welding tip is secured to one end of the electrode and it has means for temporarily energizing its connected thereto. A piston is positioned in the passageway and a solenoid is connected to a control valve for the passageway ports so that air can be admitted to or expelled from the passageway to drive the piston along the passage and strike the welding tip.

2,402,381—Process of Welding and Apparatus Therefor—Isaac M. Diller, inventor, Upper Montclair, N. J. (8 Claims)

The welding process is for use with very thin sheet metal and comprises placing the edges to be welded in light edge-to-edge contact, and confining edge zones of the metal between a pair of opposed cooperating members of nonconductive refractory material that bridge the seam between the edges. Then current is passed through the abutted edges to heat them to welding temperature after which the edges are pressed together and coalesce as they cool.

2,402,431—Welder's Headgear—Joseph L. Morow, inventor, Wilkinsburg, Pa., assignor to Dravo Corp. (14 Claims)

This patent covers a special friction joint between a welding visor and a safety helmet.

A.S.A. YEAR BOOK

The American Standards Association announced publication of its 1945-46 Year Book.

The book gives information about officers and members of the Board of Directors, of the Standards Council and other policy-forming committees of the American Standards Association. It also carries such basic documents as the Constitution and By-Laws of the A.S.A.

The center section of the book is devoted to a listing of approved American Standards and projects.

Those interested may obtain copies of the Year Book free of charge by writing to the American Standards Association at 70 East 45th St., New York 17, N. Y.

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TENTATIVE PROGRAM

AMERICAN WELDING SOCIETY
TWENTY-SEVENTH ANNUAL MEETING
WEEK OF NOVEMBER 17, 1946

THE AMBASSADOR, ATLANTIC CITY, N. J.

MONDAY, NOVEMBER 18th, Morning

THREE SIMULTANEOUS SESSIONS

WELDABILITY

Chairman—GILBERT E. DOAN, Lehigh University

Vice-Chairman—CLARENCE E. JACKSON, Union Carbide & Carbon Res. Labs.

Cracking and Ductility in the Heat-Affected Zone of Metal Arc Welds
by C. B. VOLDRICH, Battelle Memorial Institute

An Investigation of the Effect of Welding on the Transition Temperatures of Navy High Tensile Low-Alloy Steels
by G. G. LUTHER, R. E. METIUS, C. E. HARTBOWER and F. H. LAXAR, Naval Research Laboratory

Investigations of Toughness of Steel Material of Medium Thicknesses and Mode of Rupture, Under the Influence of Geometrical Constraint Without the Presence of Severe Notch Effects
by A. R. ANDERSON, Cramp Shipbuilding Corp.

RAILROAD

Chairman—A. G. OEHLER, Assoc. Editor, Railway Age

Vice-Chairman—J. W. SHEFFER, American Car and Foundry Co.

Quantity Production of Railroad Passenger Cars by Resistance Welding
by A. M. UNGER, Pullman-Standard Car Manufacturing Co.

Locomotive Boilers—Welded Construction
by JAMES PARTINGTON, American Locomotive Co.

Welded Freight Car Construction
by R. L. REX, Air Reduction Sales Co.

ELECTRODES

Chairman—J. H. DEPPELER, Metal & Thermit Corp.

Vice-Chairman—J. H. HUMBERSTONE, Arcrods Corp.

The E601X Electrode Group
by ORVILLE T. BARNETT, Metal & Thermit Corp.

Some Recent Developments in the Manufacture of Fluxes for Automatic Submerged Arc Welding
by DR. WILLI M. CONN, Pacific Flux Company, Inc.

Development and Application of Lime Ferritic Electrodes
by D. L. MATHIAS and A. P. BUNK, Metal & Thermit Corp.

Monday Afternoon

THREE SIMULTANEOUS SESSIONS

RESEARCH

Chairman—G. E. CLAUSSEN, Chairman, University Research Committee

Vice-Chairman—MARVIN SEDAM, Alloy Rods Co.

Arc Atmospheres and Underbead Cracking
by M. W. MALLETT and P. J. RIEPPEL, Battelle Memorial Institute

Influence of Residual Stress on the Fatigue Properties of Notched Mild Steel
by J. T. NORTON, D. ROSENTHAL and S. B. MALOOF, Massachusetts Institute of Technology

The Weldability of Ship Steels: Effects of Travel Speed, Preheat Temperature, and Arc Power Level on Notch Toughness
by ERNEST E. NIPPES and WARREN F. SAVAGE, Rensselaer Polytechnic Institute

Some Observations on the Weldability of High Strength Wrought Aluminum Alloys
by W. R. APBLETT, Naval Research Laboratory

PRODUCTION

Chairman—J. J. CHYLE, A. O. Smith Corp.

Vice-Chairman—F. J. WHITNEY, JR., Heintz Manufacturing Co.

Automatic Gas Shielded Welding
by G. J. GIBSON, Air Reduction Sales Co.

Jigs and Fixtures for Automatic Fusion Welding
by L. J. BERKELEY, Penn Tool and Machine Co., and E. D. MORRIS, The Linde Air Products Co.

Tool and Die Welding
by A. R. BUTLER and FRANK E. KESSLER, Welding Equipment & Supply Co.

Welding of Electric Apparatus
by E. F. POTTER, Works Laboratory, General Electric Co.

STORAGE TANKS AND PRESSURE VESSELS

Chairman—H. O. HILL, Bethlehem Steel Co.

Vice-Chairman—HARRY IRRGANG, W. K. Mitchell Co.

Field Erected Pressure Vessels
by FRED L. PLUMMER, Hammond Iron Works

Dry Seal Gas Holders, All-Welded
by RUDOLF KRAUS, Stacey Bros. Gas Construction Co.

Submerged-Melt Welding in Pressure Vessel Fabrication
by N. G. SCHREINER, The Linde Air Products Co.

Monday Evening

ADAMS' LECTURE

Chairman—J. D. GORDON, Progressive Welder Co.

Vice-Chairman—W. G. THEISINGER, Lukens Steel Co.

Lecture by DR. WENDELL F. HESS, Rensselaer Polytechnic Institute

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TUESDAY, NOVEMBER 19th, Morning

THREE SIMULTANEOUS SESSIONS

RESEARCH

Chairman—CHARLES H. JENNINGS, Westinghouse Electric Corp.

Vice-Chairman—GEORGE G. LUTHER, Naval Research Laboratory

Computation of Cooling Time in Butt Welds
by D. ROSENTHAL, Massachusetts Institute of Technology

Effect of Peening on Residual Welding Stresses
by E. PAUL De GARMO, FINN JONASSEN and J. L. MERIAM, University of California

Welding of High Strength Steels with Ferritic Electrodes
by S. A. HERRES and P. E. WOODWARD, Watertown Arsenal Laboratory

MACHINERY

Chairman—L. S. McPHEE, Whiting Corp.

Vice-Chairman—A. J. RAYMO, Baldwin Locomotive Works

The Evolution of Diesel Engine Block Weldment Designs
by JAMES W. OWENS, Fairbanks-Morse & Co.

Coordination of Engineering and Production in the Manufacture of Welded Products
by E. C. BREKELBAUM, Harnischfeger Corp.

The Metallurgical Effect of Flame Hardening Applications
by O. M. HARRELSON, Georgia School of Technology

RESISTANCE WELDING

Chairman—R. E. POWELL, Western Electric Co.

Vice-Chairman—B. L. WISE, Federal Machine & Welder Co.

Flashwelding of Concentrated Areas Up to 24 Sq. Inches in SAE 1020, NE 9440, and NE 8620 Steels
by D. BRUCE JOHNSTON, McPhee and Johnston

Resistance Welding of Spring Steel to Low Carbon Steel
by ARTHUR WILLINK, Registered Professional Engineer

Design for Resistance Welding Applications
by I. A. CRAWFORD, Progressive Welder Co.

Tuesday Afternoon

THREE SIMULTANEOUS SESSIONS

RESEARCH

Chairman—JOHN W. GORE, Bethlehem Fairfield Shipyard

Vice-Chairman—H. L. INGRAM, JR., Air Reduction Sales Company

Redistribution of Residual Welding Stresses by Tensile Loading Along a Unionmelt Weld Joining Two 3 Ft. x 12 Ft. x 1 In. Plates.
by J. L. MERIAM, E. PAUL DeGARMO and FINN JONASSEN, University of California

Welding Research as Applied in the South
by W. W. AUSTIN, JR. and E. N. KEMLER, Southern Research Institute

Welding of Hardenable Steels with High-Alloy (Austenitic) Electrodes
by MISS A. M. TURKALO and CAPT. S. A. HERRES, Watertown Arsenal Laboratory

An Investigation of the Phenomenon of Cleavage Type Fractures in Low-Alloy Structural Ship Steels
by H. J. GERSHENOW and G. G. LUTHER, Naval Research Laboratory

SHIPBUILDING

Chairman—H. W. PIERCE, New York Shipbuilding Corp.

Vice-Chairman—T. M. JACKSON, Sun Shipbuilding & Dry Dock Co.

Some Problems in Welding Design and Fabrication of Steel Floating Dry Docks
by A. AMIRIKIAN, Bureau of Yards and Docks, Navy Department

New Developments in Shipwelding
by PAUL FFIELD, Shipbuilding Division, Bethlehem Steel Co.

Discussion—Final Report of the Board to Investigate the Design and Methods of Construction of Welded Steel Merchant Vessels
by COMDR. R. D. SCHMIDTMAN, J. LYELL WILSON, and FINN JONASSEN, Members of the Sub-board

RESISTANCE WELDING

Chairman—R. T. GILLETTE, General Electric Company

Vice-Chairman—GEORGE N. SIEGER, S-M-S Corp.

Resistance Welding With Storage Batteries
by JOHN D. GORDON, Progressive Welder Co.

Thermal Resistance of Metal Contacts
by W. B. KOUWENHOVEN, Dean, School of Engineering, and MR. POTTER, Johns Hopkins University

A Summary on the Spot Welding of High Tensile Carbon and Low-Alloy Steels
by W. D. DOTY and WYLIE J. CHILDS, Rensselaer Polytechnic Institute

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Tuesday Evening

UNIVERSITY RESEARCH CONFERENCE

WEDNESDAY, NOVEMBER 20th, Morning

THREE SIMULTANEOUS SESSIONS

STRUCTURAL

Chairman—F. H. FRANKLAND,
Consulting Engineer

Vice-Chairman—W. E. HENDRICKS,
Belmont Iron Works

H-Section Welded Trusses
by A. T. WEIDELICH, The Austin Co.

Welded Pier Leg, Shear Leg and Trolley of a 15-Ton Ore Bridge
by GEO. F. WOLFE, Dravo Corp.

Recent Trends in Concepts of Design of Welded Steel Structures
by LaMOTTE GROVER, Air Reduction

CUTTING

Chairman—JOHN J. CROWE,
Air Reduction Sales Co.

Vice-Chairman—A. B. GORDON,
The Linde Air Products Co.

Automatic Oxyacetylene Operations
by S. D. BAUMER, Air Reduction Sales Co.

Heavy Cutting Applications in Foundry and Steel Mill
by R. S. BABCOCK, The Linde Air Products Co.

Stainless Steel Cutting
by HOWARD HUGHEY, Air Reduction Sales Co.

RESISTANCE WELDING

Chairman—O. C. FREDERICK,
General Electric Company

Vice-Chairman—JOHN CUMBERLAND,
Arcway Equipment

Additional Timing Period of New Motor Driven Control Increases Gun Welder Speed
by H. I. STANBACK, Square D Company

Radiography and the Fatigue Strength of Spotwelds in Aluminum Alloys
by ROBERT C. McMASTER and HORACE T. GROVER, Battelle Memorial Institute

Resistance Welding
a General Electric film to be shown by L. D. T. BERG, General Electric Co.

Wednesday Afternoon

THREE SIMULTANEOUS SESSIONS

RESISTANCE WELDING

Chairman—K. W. OSTROM,
K. W. Ostrom & Company

Vice-Chairman—E. S. ELWOOD,
Taylor Winfield Corp.

Choice of Cable and Transformer Size for Portable Spot Welder
by MYRON ZUCKER, Mackworth G. Rees, Inc.

Three Phase Balanced Load Resistance Welding Machines,
by MARIO SCIAKY, Sciaky Brothers

The Flash-Welding of Hard-Drawn High Carbon Steel Wire
by R. W. BENNETT and R. D. WILLIAMS, Battelle Memorial Institute

Selecting Spotwelding Schedules for Low Carbon Steel
by JULIUS HEUSCHKEL, Westinghouse Electric Laboratories

CUTTING

Chairman—J. H. ZIMMERMAN,
The Linde Air Products Co.

Vice-Chairman—JOHN D. BERT,
Philadelphia Navy Yard

Arc Oxygen Cutting on the Surface and Underwater
by CHARLES KANDEL, Craftsweld Equipment Corp.

Powder Cutting and Scarfing of Oxidation-Resistant Materials
by D. H. FLEMING, The Linde Air Products Co.

Recent Canadian Contributions to Oxygen Cutting, and Film "No Keener Blade"
by R. A. DUNN, Canadian Liquid Air Company, Ltd.

Oxygen Cutting of Steel at Elevated Temperatures
by J. F. KIERNAN and J. S. SOHN, Air Reduction Sales Co.

MISCELLANEOUS

Chairman—R. D. THOMAS, JR.,
Arcos Corp.

Vice-Chairman—A. A. HOLZBAUR,
Sun Shipbuilding Co.

The Arc Welding of Cast Iron with Nickel Electrodes
by T. E. KIHLGREN and L. C. MINARD, The International Nickel Co.

The Control of Weld Hot Cracking in Nickel-Chromium-Iron Alloys
by T. E. KIHLGREN and C. E. LACY, The International Nickel Co.

Navy-E.E.S. Method for Determining the Applicable Welding Procedures for Steels
by BELA RONAY, U. S. Naval Engineering Experimental Station

Investigation of the Weldability of Copper Bearing Steels
by N. H. KEYSER & C. H. LORIG, Battelle Memorial Institute

Wednesday Evening

SECTION ACTIVITIES

Chairman—F. W. DAVIS,
Chairman, Section Advisory Committee

Vice-Chairman—J. F. MAINE,
Past Chairman, Cleveland Section

Section Officers will hold their Annual Dinner and Meeting to be followed by a special open session on Section operation involving presentation of papers and discussion by Section Representatives

THURSDAY, NOVEMBER 21st, Morning

THREE SIMULTANEOUS SESSIONS

HARD FACING

Chairman—A. V. HARRIS, Haynes Stellite Co.

Vice-Chairman—M. W. BREWSTER, Westinghouse Electric Corp.

Repairing Contractors and Steel Mill Equipment with Manganese Application Bars
by L. A. DAVIS, Manganal Div., Stulz Sickles Co.

How to Select Wear Resisting Alloys for Welding
by JOSEPH A. CUNNINGHAM, J. A. Cunningham Equipment, Inc.

Microstructure of Hard Facing Alloys
by H. W. SHARP, Stoody Co.

Composite Construction by Building Up Surfaces with Submerged-Melt Welding
by J. E. TAYLERSON, The Linde Air Products Co.

AIRCRAFT

Chairman—G. S. MIKHALAPOV, Air Reduction Sales Co.

Vice-Chairman—P. H. MERRIMAN, The Glenn L. Martin Co.

Design and Production Control Silver Alloy Brazed Joints in Aircraft Structures
by H. A. SMITH, and P. A. KOERNER, Beech Aircraft Co.

Resistance Welding Test Methods Used to Maintain Quality in the Manufacture of the 140 Jet Engine
by P. G. PARKS, Solar Aircraft Co.

Submerged Melt Welding of Alloy Steel Aircraft Propeller Blades
by A. W. STEINBERGER, Curtiss-Wright Corp., Propeller Division

Welding Problems in Jet Propulsion—Stainless Steel
by E. J. DeWITT and MR. LAMMERS, Wallace Supplies Mfg. Co.

PRESSURE WELDING

Chairman—A. B. KINZEL, Union Carbide & Carbon Res. Labs.

Vice-Chairman—A. T. LIGHT, York Corporation

Open Butt Oxyacetylene Compression Welding
by H. H. CHISWIK, Air Reduction Sales Co.

Pressure Welding of Low Alloy Steels and Some Non-Ferrous Alloys
by K. H. KOOPMAN, Union Carbide and Carbon Research Labs., Inc.

Pressure Welding Propeller Hubs and Stainless Steel Rings
by GEORGE MOTHERWELL, Wyman-Gordon Co., and C. J. BURCH, The Linde Air Products Co.

Pressure Gas-Welding of Alloy Steel Tubing
by Z. L. ZAMBROW and R. D. WILLIAMS, Battelle Memorial Institute

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Thursday Evening

DINNER

PRESENTATION OF MEDALS AND PRIZES

Chairman—WENDELL F. HESS, President, American Welding Society

Vice-Chairman—E. V. DAVID, Chairman, Convention Committee

FRIDAY, NOVEMBER 22nd, Morning

THREE SIMULTANEOUS SESSIONS

HIGH ALLOYS

Chairman—R. D. THOMAS, SR., Arcos Corp.

Vice-Chairman—E. R. McCLUNG, Lukenweld, Inc.

An Attempt to Select a Suitable Specimen for the Study of Corrosion Cracking in 18-8 Steel
by D. S. McKINNEY, Carnegie Institute of Technology

Hastelloy Welding and Fabrication Methods
by C. G. CHISHOLM, Haynes Stellite Co.

Effect of Alloying Elements on the Tensile Properties of 25-20 Weld Metal
by HALLOCK C. CAMPBELL and R. D. THOMAS, JR., Arcos Corp.

MISCELLANEOUS

Chairman—G. V. SLOTTMAN, Air Reduction Sales Co.

Vice-Chairman—L. D. T. BERG, General Electric Co.

Submerged-Melt Welding of Corrosion-Resisting Metals
by H. J. ROBERTS, The Linde Air Products Co., and R. J. ANDERSON, Dominion Oxygen Co., Ltd.

Application of Quality Control to Aircraft Welding
by T. E. PIPER, Northrop Aircraft, Inc.

Production Applications of Inert-Gas-Shielded Arc Welding
by H. T. Herbst, The Linde Air Products Co.

MISCELLANEOUS

Chairman—H. B. SEYDEL, Air Reduction Sales Co.

Vice-Chairman—G. R. JOHNSON, The Lincoln Electric Co.

The Development and Applications of High Strength Welding Quality Alloy Steels
by HOWARD L. MILLER, Republic Steel Corp.

Plant Maintenance—Welding and Other Applications of Our Process
by E. C. CHAPMAN and R. E. LORENTZ, JR., Combustion Engineering Co.

A New Semi-Automatic Arc Welding Process
by J. M. TYRNER, Air Reduction Sales Co.

Friday Afternoon

Business Meeting
Board of Directors Meeting